

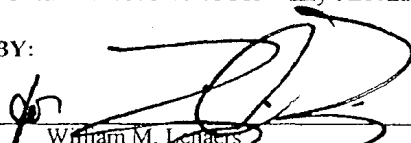
INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN & ENVIRONMENTAL ASSESSMENT

Picatinny Arsenal Dover, New Jersey

Signature Page

This Integrated Natural Resources Management Plan (INRMP) meets the requirements for INRMPs listed in the *Sikes Act* as amended (16 U.S.C. sec 670a et seq.). It sets appropriate guidelines for conserving and protecting the natural resources of Picatinny Arsenal.

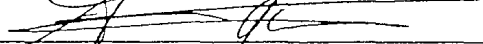
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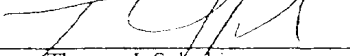
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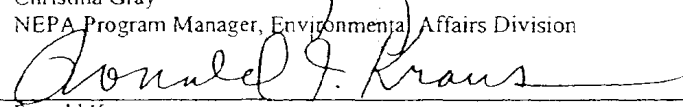
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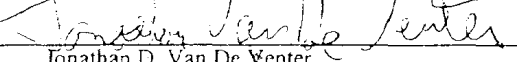
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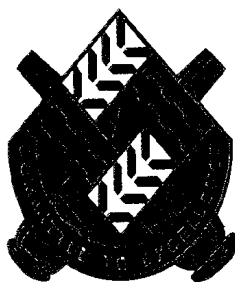
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ENVIRONMENTAL ASSESSMENT

IMPLEMENTATION OF AN INTEGRATED NATURAL RESOURCE MANAGEMENT PLAN

For
Department of the Army
U.S. Army Tank-Automotive and Armaments Command
Armament Research,
Development and Engineering Center
(TACOM-ARDEC)



Prepared for

PICATINNY ARSENAL
DOVER, NEW JERSEY

Prepared through

Interagency Agreement
With The
United States Army Environmental Center

May 2001

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Picatinny Arsenal

Executive Summary

PROPOSED ACTION

The Armament Research, Development, and Engineering Center (ARDEC) Commander proposes to manage Picatinny Arsenal's natural resources through the implementation of a revised Integrated Natural Resources Management Plan (INRMP) that complies with the *Sikes Act Improvement Act*, DoD Instruction 4715.3, Army Regulation 200-3, and other applicable laws and regulations. Furthermore, the Commander proposes to manage natural resources on the installation with consideration of ecosystems that extend beyond the installation's boundaries and in cooperation with the U.S. Fish and Wildlife Service and the New Jersey Department of Environmental Protection. The period of the INRMP will be extended to 2004, unless otherwise revised (INRMP 1996).

PURPOSE AND NEED

The purpose of the proposed action is to meet the requirements of the *Sikes Act* as amended through 1997 and to enhance natural resources integration while planning and conducting the military mission. It is also to continue to protect Threatened and Endangered Species given new information about species such as the Indiana bat and the bog turtle, and to consider the state and private land initiatives adjacent to the Arsenal's boundary.

The *Sikes Act* (16 United States Code U.S.C. 670a et seq.), as amended in the *Sikes Act Improvement Act* of 1997, requires that the Army manage the natural resources of its military installations within the United States to provide: (1) sustained multipurpose use of natural resources, and (2) public access that is necessary or appropriate for designated uses to the extent that such uses are consistent with the military mission. The *Sikes Act* also requires coordination between each installation, the U.S. Fish and Wildlife Service (USFWS), and appropriate state agencies on plans that promote the development, maintenance, and conservation of fish and wildlife or the rehabilitation of habitat. Department of Defense (DoD) Instruction 4715.3, *Environmental Conservation Program* (3 May 1996), requires that all military installations that have habitat suitable for conserving and managing natural ecosystems prepare Integrated Natural Resource Management Plans (INRMP).

This environmental assessment (EA) evaluates the potential effects of the revised Integrated Natural Resource Management Plan to be implemented at Picatinny Arsenal and summarizes and compares the potential environmental consequences of the identified alternatives. The Armament Research, Development, and Engineering Center (ARDEC) Commander will select the most effective alternative for managing the Arsenal's natural resources, protecting Threatened and Endangered Species, and integrating the Arsenal's habitat with the region as a whole that is consistent with the installation mission and resource capability.

ISSUES IDENTIFIED

This document has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), its implementing regulations published by the Council on Environmental Quality (CEQ), and Army Regulation 200-2, *Environmental Effects of Army Actions*. Preliminary issues were identified by a survey of the Arsenal, review of prior environmental assessments, comments received from higher headquarters (Army Materiel Command), and consultation with resource specialists from appropriate New Jersey State and federal agencies to include the US Fish and Wildlife Service

Nine issues were identified:

1. Potential loss of Indiana bat foraging areas near hibernacula: In addition, Indiana bats have been documented to roost in mine shafts on private land immediately adjacent to the Arsenal. All three of New Jersey's known bat hibernacula sites are within 2.5 miles of the Arsenal. Bats associated with these hibernation sites have been documented to forage on the facility prior to hibernation.
2. Preservation of Indiana bat roosting habitat: Female Indiana bats have been known to occupy summer maternity roosts under loose tree bark along riparian and floodplain forests. Although no roost trees have been found to date on the Arsenal, there are trees and areas that could potentially provide habitat. Threats to such trees include fire, wind events, and possibly new construction.
3. Potential loss of bog turtle habitat: In October 1998, the federally "Threatened" bog turtle (*Clemmys muhlenbergii*) was confirmed within the Arsenal boundary. Bog turtles also occur in herbaceous wetlands (like those on Picatinny), spring-fed fens, and within wetlands that contain emergent or shrub/scrub wetlands.
4. Impacts on state listed wildlife: Although Department of Defense facilities are required to protect only federally listed Threatened and Endangered Species, there are a number of state listed species that occur on the Arsenal. These include "target" species that have been identified and ranked by the New Jersey Landscape Project and depend on habitat characteristics present on the Arsenal.
5. Ability of Upper Green Pond Brook to support brook-trout production (state designated): The state has designated a portion of Green Pond Stream that is on Picatinny Arsenal as a trout "production" stream (as distinguished from "maintenance"). The designation has implications for the protection of the stream and the trout resource.
6. Biodiversity and habitat connectivity: Two potential barriers to wildlife movement are fragmented habitats (forests, grasslands, wetlands) and ownership patterns that result in development. Fragmentation makes may affect foraging, roosting, and denning. It also may be a problem for certain neotropical migratory birds. Neotropicals currently migrate through the Highlands Region in large numbers.
7. Potential increase in non-native plant species and invasive species: Non-native plant species can pose a threat to sensitive and rare plants that are native to an area. They can also have a detrimental impact on the ecosystem by replacing native vegetation that has evolved within a unique niche over many generations.
8. Loss or deterioration of state listed plants: The state of New Jersey is concerned about the impact of non-native species on native plant species and wildlife. Non-native species, such as autumn olive, exist to some degree on the Arsenal.
9. Access to installation facilities and natural resources for outdoor recreation: Currently the Arsenal is closed to the general public for recreational use. Nevertheless, public demand for access is increasing and the *Sikes Act Improvement Act* directs installations to provide access to the extent that such access is consistent with the military mission and resource protection.

ALTERNATIVES CONSIDERED IN DETAIL

Three different alternatives for addressing the issues identified and managing the associated natural resources were evaluated. As a minimum, each alternative complies with existing laws, regulations, and policy requirements, although the No-Action Alternative may not meet all requirements of the *Sikes Act Improvement Act* of 1997 or the intent of AR 200-3. A fourth alternative as indicated below was eliminated from further study

Alternative A, No-Action: In accordance with regulations promulgated by the Council on Environmental Quality (CEQ) 43 Code of Federal Regulations (CFR), Part 1500, Section 1502.14(d), a "No-Action" Alternative must be considered. At the current time, an Integrated Natural Resource Management Plan (INRMP) finalized in 1996 has been implemented at the Arsenal. The No-Action Alternative would not immediately change management direction or the level of management intensity. Therefore, the Arsenal would continue to operate using the existing plan and management practices and would maintain current conditions. Although the No-Action Alternative would not result in the absence of any or all management activity, it would not address the Indiana bat, bog turtle, or habitat connectivity.

Alternative B, Targeted Resource Protection and Management: This alternative would address the issues at various management intensity levels. It would specifically target newer issues such as Indiana bat and bog turtle habitat, habitat connectivity on the landscape, and brook trout production for high intensity management. Other issues would receive less emphasis and would be addressed as resources allow. New information and requirements would be incorporated and it would fully comply with the *Sikes Act Improvement Act* and with Army Regulation 200-3 and DOD Instruction 4715.3. The different levels of management would also be integrated with other installation plans and with the military mission. This is the preferred alternative.

Alternative C, Maximum Protection and Enhancement: This alternative would address all the issues (new and old) to the maximum extent possible, subject to funding and personnel constraints. For some of the issues identified, it would provide enhanced protection over current levels or those proposed as part of the Targeted Protection and Management Alternative. This high intensity alternative would involve new initiatives to increase either species habitat or the populations of the species present on the Arsenal. It would fully comply with the *Sikes Act Improvement Act* and with Army Regulation 200-3 and with DOD Instruction 4715.3. It would be integrated with the military mission, but could have the potential to affect mission capabilities or expansion.

Discontinue Further Actions: This alternative would involve discontinuing all actions as part of the current Integrated Natural Resources Management Plan. It would be a true "no-action" alternative. It was eliminated from further study because it would not comply with the *Sikes Act Amendment Act*, Army Regulation (AR) 200-3, and other DoD directives.

ENVIRONMENTAL CONSEQUENCES, ALTERNATIVE B (PREFERRED)

Rare, Threatened, and Endangered Animal Species

Indiana Bat: Regulating development in riparian areas and limiting tree cutting would provide increased protection for primary habitat. The buffer zones established along stream banks and around wetlands would enhance potential foraging areas. Potential foraging habitat would be maintained by restricting timber harvest and firewood cutting and providing information about the bat and bat habitat to the public. Despite not having documented roosting sites within its boundary, habitat within the potential foraging area in the SE portion of the Arsenal would be protected. Curtailing or prohibiting selected timber activities and firewood cutting would maintain or increase potential roost sites. Surveys would be conducted to identify actual roosting sites. Given the emphasis on preserving snags, the potential roost sites would increase. Additional protection of potential and/or existing sites by establishing no cut zones, marking trees, and setting guidelines for snags would tend to stabilize the foraging and roosting bat population.

Bog Turtle Habitat: In order to prevent flooding of habitat, beaver dams would likely be breached and individual beavers or clans would likely be displaced. Woody vegetation would be deadened by appropriate means that would result in a net increase in herbaceous vegetation. Natural succession would thereby be reversed and the shrubland would revert to more of a meadow environment. Removal of beaver dams and the killing of seral vegetation as necessary would tend to stabilize the hydrology of the wetland. This in turn would maintain the turtle population to the extent that turtles occur. Maintaining buffer areas would help to prevent inadvertent habitat damage or water quality degradation.

State-Listed Wildlife: There would be no incremental effects in the field or on the ground. Surveys and documentation would provide baseline data. Potentially positive effects would result from conducting surveys prior to ground-disturbing activities. Also, the plotting of species location would avoid unnecessary damage to associated habitats. If residency is documented, habitats would be protected or improved. The protection of habitats once identified would increase species viability.

Fish Species and Water Quality: Controlling water temperature and maintaining stream flow, channel stability, and habitat complexity would likely expand the brook trout population into the middle portion of Green Pond Brook. This would increase species diversity in the middle portion of the brook and would tend to stabilize the trout population in the upper portion of Green Pond Brook. The threat of extirpation would be reduced. No degradation of water quality, wetlands or aquatic habitats is anticipated. Protection of riparian areas and establishment of buffer zones would likely improve water quality by reducing sedimentation, reducing water temperature, and possibly reducing contamination from non-point sources. The Arsenal would continue to be an important link in Watershed Number 6 and the Highlands Region. Management actions would be neutral or beneficial to water quality.

Wildlife and Habitat Connectivity: Maintaining riparian, grassland, and forest connectivity would protect species diversity. Restricting harvest activities, maintaining unroaded areas, and protecting dispersal habitat would minimize fragmentation of forest and other habitats. Unfragmented interior forest would continue to support neotropical migrants. Management and silviculture activities would be consistent with land management areas outside the Arsenal boundary further enhancing habitat connectivity throughout the larger region. There would be no immediate impact on game species, however, to the extent that various habitats remain intact and support migration, game populations would likely increase given the general improvement in habitat connectivity, the protection of riparian areas, and retention of old-growth and interior forest. Coordination with adjacent landowners and managers would result in management actions that could increase dispersal habitat, create forest openings in selected areas, and improve connectivity.

State-Listed Plants: Using site-specific surveys prior to ground-disturbing activities would encourage the survival of state-listed plants, especially for those species considered to be Endangered. Site surveys would prevent the inadvertent destruction of plants. Since the majority of the plants are aquatics, preservation of water quality would enhance state-listed populations. The additional public information provided would also help prevent the inadvertent destruction of plants of conservation concern.

Socioeconomic Factors: There would be no change from the current condition. However, positive effects would accrue from the educational awareness activities and minimizing disturbance to select plant and animal species. For some species such as deer, hunting would be an effective management tool for controlling the population. The protection of riparian areas and potential roost trees would prevent negative effects on Indiana bats. Bog turtle habitat characteristics are such that they provide a natural barrier to human intrusion. Current restrictions and controls would keep impacts to a minimum. Further reductions or restrictions of activity would be based on safety concerns.

CUMULATIVE EFFECTS

The preferred Alternative would follow an integrated ecosystem approach and would incorporate existing installation planning documents and management plans. The revised INRMP would also further establish or continue existing partnerships with federal, state, and local agencies and organizations. Coordination with adjacent land managers would also be enhanced. The INRMP programs and standards and guidelines would have the positive cumulative effects of enhancing environmental quality; improving connectivity; and protecting species, especially the Indiana bat, bog turtle, and brook trout. Associated monitoring would contribute to a reduction in negative cumulative effects through adaptive management. Surveys would provide additional information and help to establish baseline data. New information would be incorporated into the INRMP during the annual review or at the five-year review period.

1.0 CHAPTER 1 PROPOSED ACTION

PROPOSED ACTION

The Armament Research, Development, and Engineering Center (ARDEC) Commander proposes to manage Picatinny Arsenal's natural resources through the implementation of a revised Integrated Natural Resources Management Plan (INRMP) that complies with the *Sikes Act Improvement Act*, DoD Instruction 4715.3, Army Regulation 200-3, and other applicable laws and regulations. Implementing the plan will further enhance ecosystem management and will protect and enhance ecosystem components in concert with fulfilling the Arsenal's mission. In addition, the Commander proposes to manage natural resources on the installation with consideration of ecosystems that extend beyond the installation's boundaries and in cooperation with the U.S. Fish and Wildlife Service and the New Jersey Department of Environmental Protection. The period of the INRMP, which currently includes fiscal years 1997 through 2001, will be extended to 2004 unless otherwise revised (INRMP 1996).

2.0 CHAPTER 2 PURPOSE AND NEED

2.1 PURPOSE

The purpose of the proposed action is to meet the requirements of the Sikes Act as amended through 1997 and to integrate natural resource management with planning and conducting the military mission. The purpose is also to continue protecting Threatened and Endangered Species given new information about species such as the Indiana bat and the bog turtle, and to consider the state and private land initiatives adjacent to the Arsenal's boundary. Natural resource management at Picatinny Arsenal is dictated by its primary military mission and by the Arsenal's relationship to the surrounding larger region. This environmental assessment (EA) evaluates the potential effects of the revised Integrated Natural Resource Management Plan to be implemented at Picatinny Arsenal and summarizes and compares the potential environmental consequences of the identified alternatives.

2.2 NEED FOR ACTION

The need for developing a revised INRMP is to ensure that natural resource conservation measures and military activities on mission land are integrated and are consistent with federal stewardship requirements. Implementing the revised INRMP at the Picatinny Arsenal would ensure that the installation continues to comply with the *Sikes Act Improvement Act* and with other federal laws, especially those associated with wetlands, water quality, endangered species, and wildlife and habitat management. In addition, the revised Integrated Natural Resource Management Plan would ensure natural resources system integrity through effective integration of new information regarding Threatened and Endangered Species and habitat in the surrounding area.

The *Sikes Act* (16 United States Code U.S.C. 670a et seq.), as amended in the *Sikes Act Improvement Act* of 1997, requires that the Army manage the natural resources of its military installations within the United States to provide: (1) sustained multipurpose use of natural resources, and (2) public access that is necessary or appropriate for designated uses to the extent that such uses are consistent with the military mission. The *Sikes Act* also requires coordination between each installation, the U.S. Fish and Wildlife Service (USFWS), and appropriate state agencies on plans that promote the development, maintenance, and conservation of fish and wildlife or the rehabilitation of habitat.

Department of Defense (DoD) Instruction 4715.3, *Environmental Conservation Program* (3 May 1996), requires that all military installations that have habitat suitable for conserving and managing natural ecosystems prepare Integrated Natural Resource Management Plans (INRMP). Furthermore, DoD has directed that ecosystem management be the guiding principle for developing and implementing the INRMP. The goal of ecosystem management is to preserve, improve, and enhance natural resources system integrity and biodiversity conservation.

Development and implementation of the INRMP is guided by Army Regulation (AR) 200-3, *Natural Resources – Land, Forest, and Wildlife Management*. It provides the "policy, procedures, and responsibilities for conservation, management, and restoration of land and the natural resources." Army Regulation 200-3 requires that the INRMP be reviewed annually and revised as necessary to incorporate new information or requirements. The AR requires major revisions of the INRMP at least every five years. The INRMP must also be compatible with the installation's Master Plan, Pest Management Plan, and Master Training Schedule.

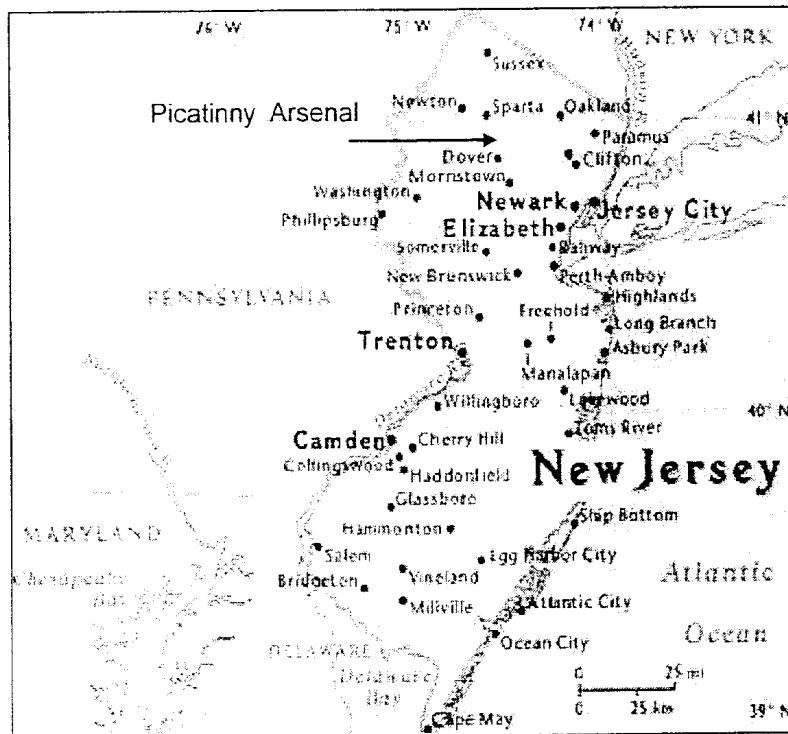
2.3 DECISION TO BE MADE

The Armament Research, Development, and Engineering Center (ARDEC) Commander will select the most effective alternative for managing the Arsenal's natural resources, protecting Threatened and Endangered

Species, and integrating the Arsenal's habitat with the region as a whole that is consistent with the installation mission and resource capability.

2.4 LOCATION OF THE INSTALLATION

The Arsenal is located in the New Jersey Highlands and is part of Watershed Management Area Number 6 (see maps on pages 65 and 73). Located in northern New Jersey 28 road miles northwest of New York City, this region is a greenbelt for a heavily populated area and provides open space, recreation, and scenic beauty for millions of people. Over four million people rely on the area for clean drinking water.



The Arsenal, covering 6,500 acres and containing two lakes, has 2.7 million square feet of indoor area, about half of which are devoted to research activities. Within its structures work three thousand employees, more than half devoted exclusively to scientific and engineering endeavors. Various facilities dot the scenic valley floor and the steep slopes of the surrounding hills.

2.5 MILITARY MISSION

Picatinny Arsenal is home to a number of tenant organizations including the U.S. Army Armament Research, Development and Engineering Center (ARDEC), and is Program Executive Officer for Ground and Combat Support Systems and various other related activities. The ARDEC is a subordinate command of the US Army Tank – Automotive and Armaments Command (TACOM). The TACOM-ARDEC mission is to execute and manage life-cycle engineering processes required for research, development, production, field support, and demilitarization of ammunition, weapons, fire control, and associated items. It is also to provide procurement and management of initial production quantities and technical support to soldiers and equipment in the field, and to maintain a technology base to facilitate the design, development, procurement, production, and life-cycle support of assigned material or transitioned technologies.

Currently, the design and development functions are paramount. Production is essentially limited to creating prototypes for testing and procurement. As a part of the development and testing process, the installation stores various types of ammunition and explosives in specially designed bunkers. The storage of ammunition and explosives creates safety and security issues that limit access and restrict the use of certain parts of the land base. The vision of the TACOM-ARDEC is to provide overwhelming firepower for decisive victory through the integration of complex armament technologies into guns, ammunition, and fire control systems through research, development, acquisition, and sustainment.

2.6 SCOPING AND ISSUES

This document has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), its implementing regulations published by the Council on Environmental Quality (CEQ), and Army Regulation 200-2, *Environmental Effects of Army Actions*. This EA is programmatic in nature and is designed to identify, assess, and disclose to the decision-maker and the public the broad environmental impacts expected to result from the proposed action.

Preliminary issues were identified by a survey of the Arsenal, review of prior environmental assessments, comments received from higher headquarters (Army Materiel Command), and consultation with resource specialists from appropriate New Jersey State and federal agencies. Persons contacted include:

Lisa Arroyo	US Fish and Wildlife Service
Tom Breden	New Jersey Department of Environmental Protection, Office of Natural Lands Management.
Richard Brown	New Jersey Department of Environmental Protection, Office of State Plan Coordination.
Christina Gray	NEPA Coordinator, Picatinny Arsenal
Vinod Kapoor	Chief, Master Plans and Programs office, Picatinny Arsenal
Steven Karp	Geographic Systems Manager, New Jersey Department of Community Affairs.
Marcus Phelps	USDA Forest Service, Highlands Coordinator
Jessica Rittler Sanchez	Environmental projects Coordinator, New Jersey Office of State Planning
Annette Scherer	US Fish and Wildlife Service
Mike Valent	New Jersey Department of Environmental Protection, Division of Fish, Game, and Wildlife
Jonathan Van DeVenter	Natural Resource Manager, Picatinny Arsenal
Barbara Walsh	Local Planning Assistance Unit, New Jersey Department of Community Affairs.

The following issues were developed through the scoping process:

1. *Potential loss of Indiana bat foraging areas near hibernacula.*

In July 1995, the Indiana bat (*Myotis sodalis*), a federally listed endangered species, was netted and documented on Picatinny Arsenal. Portions of the Arsenal may provide important summer breeding and pre- and post-hibernation foraging habitat for the Indiana bat. In fact, the only confirmed Indiana bat summer foraging habitat documented to date within New Jersey is on Picatinny Arsenal.

In addition, Indiana bats have been documented to roost in mine shafts on private land immediately adjacent to the Arsenal. All three of New Jersey's known bat hibernacula sites are within a 2.5 radius miles of the Arsenal. Bats associated with these hibernation sites have been documented to forage on the facility prior to hibernation. Studies in Kentucky indicate that forested areas within 5 miles of a hibernaculum are used heavily by Indiana bats for foraging prior to hibernation (USFWS letter 1999).

2. Preservation of Indiana bat roosting habitat.

Female Indiana bats are known to occupy summer maternity roosts under loose tree bark along riparian and floodplain forests. They have also been recently confirmed to use upland forested habitats, especially those that contain dead trees (snags) that are near open areas, receive a significant amount of sunlight, and have loose bark that creates natural cavities (Evans et. al. 1998). Although no roost trees have been found to date on the Arsenal, there are trees and areas that could potentially provide habitat. Threats to such trees include fire, wind events, and possibly new construction.

3. Potential loss of bog turtle habitat.

In October 1998, it was revealed that a documented bog turtle site (circa 1980s) previously believed to be on nearby private land, was actually well within Picatinny Arsenal boundaries. It is assumed by state and federal biologists that the federally "Threatened" bog turtle (*Clemmys muhlenbergii*) still occupies the site. Bog turtles inhabit open, wet meadows and bogs with standing or slow-moving shallow water, usually over mucky substrate (USFWS letter 1999). Bog turtles also occur in herbaceous wetlands (like those on Picatinny), spring-fed fens, and within wetlands that contain emergent or shrub/scrub wetlands. Bog turtles prefer areas with good sunlight, high evaporation rates, high humidity in the near-ground microclimate, and perennial saturation of portions of the ground (USFWS letter 1999). Threats to the bog turtle include habitat loss from wetland alteration, natural vegetation succession, and alteration of the hydrology of an area.

4. Impacts on state listed wildlife.

Although Department of Defense facilities are required to protect only federally listed Threatened and Endangered Species, there are a number of state listed species that occur on the Arsenal. These include "target" species that have been identified and ranked by the Landscape Project and depend on habitat characteristics present on the Arsenal. The NJ Landscape Project divided the state into 5 regions, the Highlands Region Valley being one. The purpose of the project is to protect habitat for T&E species over the long run. Using satellite imagery, the area was divided into various categories: forests, grasslands, wetlands. Each category was then associated with the target species. A ranking system was developed and land and species were then ranked by importance. Land located adjacent to existing public land was assigned a higher priority or ranking.

5. Ability of Upper Green Pond Brook to support brook-trout production (state designated).

The state designated a portion of Green Pond Stream that is on Picatinny Arsenal as a trout "production" stream (as distinguished from "maintenance"). The portion of the stream that is known to produce brook trout is actually the upper portion of the stream known as Green Pond Brook. The designation has implications for the protection of the stream and the trout resource. Characteristics such as water quality, turbidity, sedimentation, water temperature, and woody debris are critical to trout production and maintenance. This designation may impact activities that occur in habitat adjacent to the brook.

6. Biodiversity and habitat connectivity.

Unfragmented dispersal habitat corridors that provide connectivity are important for maintaining biodiversity. Connectivity refers to the ability of organisms to move freely within their natural range. This is especially important in maintaining genetic and demographic viability. Two potential barriers to this movement are fragmented habitats (forests, grasslands, wetlands) and ownership patterns that in some cases result in development. Fragmentation makes dispersal more difficult and may affect foraging, roosting, and denning. It also can increase forest "edge effects" that reduce shelter from the harsh winter wind and increases the incidence of predation for some species. Forest fragmentation may be a problem for certain neotropical migratory birds. Mostly songbirds, neotropical species are primarily forest-dwelling insect feeders that typically require large forested tracts to breed successfully. Neotropicals currently migrate through the Highlands Region in large numbers. Sightings of other wildlife such as black bears, eagles, and hawks indicate that such species also migrate through the area.

7. Potential increase in non-native plant species and invasives.

Non-native plant species can pose a threat to sensitive and rare plants that are native to an area. They can also have a detrimental impact on the ecosystem by replacing native vegetation that has evolved within a unique niche over many generations. Presidential Executive Order 13112, dated February 1999, directs federal agencies to manage invasive species. The Executive order defines invasive species as any "alien species in a particular ecosystem that is not native to that ecosystem, including its seeds, eggs, spores, or other biological material capable of propagating that species." Invasive species management practices may be included in current or revised Integrated Natural Resources Management Plans (INRMPs).

8. Loss or deterioration of state listed plants.

The state of New Jersey is concerned about the impact of non-native species on native plant species and wildlife. The New Jersey Department of Environmental Protection is developing a list of non-native species and ranking them by "invasiveness." The occurrence of native species is also being validated. Non-native species, such as autumn olive, exist to some degree on the Arsenal.

9. Access to installation facilities and natural resources for outdoor recreation.

Currently, recreational use by the general public is prohibited on the Arsenal. However, historically the Arsenal has provided hunting and fishing opportunities for individuals, groups, and clubs associated with the Arsenal (employees, active and retired military) on a limited basis. The Rod and Gun Club has been, and continues to play an important role in the quality of life for many personnel assigned to the Arsenal. Limited access to discrete highly developed facilities (Aquatic Center, playing fields) are recently available to local municipalities under Memoranda of Understanding. These few focused activities and partnerships have had little or no impact on Natural Resources Management to date. Nevertheless, public demand for access is increasing and the *Sikes Act Improvement Act* directs installations to provide access to the extent that such access is consistent with the military mission. Protecting water quality and providing secure habitat for fish and wildlife, including threatened and endangered (T&E) and state target species, may affect the types of uses to be allowed in specific areas of the Arsenal.

3.0 CHAPTER 3 ALTERNATIVES

INTRODUCTION

This chapter describes the alternatives (potential actions) considered in detail and summarizes the environmental consequences. The environmental consequences are stated in the form of desired outcomes or desired future conditions (DFCs). It includes the objectives for achieving the desired future conditions and the management actions necessary to meet the objectives for each alternative.

The range of alternatives considered was defined by the proposed action and purpose and need, direction found in the documents referenced in Chapter 2, and the issues described in Chapter 2. The range of alternatives carried forward in detail met the following criteria: (1) the alternative had to be practical and feasible, and (2) the alternative had to meet the purpose and need and respond to the significant issues.

3.1 RANGE OF ALTERNATIVES

The range of alternatives is directly related to the proposed action which is to manage the natural resources of the Arsenal through a revised Integrated Natural Resources Management Plan (INRMP) that considers new information with regard to Threatened and Endangered species. The INRMP is a programmatic document. It does not propose site-specific management actions. It provides general management standards and guidelines. Therefore, the alternative options reflect different options for implementing the management plan.

3.2 ALTERNATIVE CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Discontinue Further Actions: This alternative would involve discontinuing all actions as part of the current Integrated Natural Resources Management Plan. It would be a true "no-action" alternative. It was rejected since it would not comply with the *Sikes Act Amendment Act*, Army Regulation (AR) 200-3, and other DoD directives.

3.3 ALTERNATIVES CONSIDERED IN DETAIL

Three different alternatives for addressing the issues identified and managing the associated natural resources were evaluated. The different options of No-Action (status quo), Targeted Resource Protection, and Maximum Resource Protection enabled resource managers to consider a variety of means to manage the Arsenal's natural resources. As a minimum, each alternative complies with existing laws, regulations, and policy requirements, although the No-Action Alternative may not meet all requirements of the *Sikes Act Improvement Act* of 1997 or the intent of AR 200-3.

Alternative A, No-Action: In accordance with regulations promulgated by the Council on Environmental Quality (CEQ) 43 Code of Federal Regulations (CFR), Part 1500, Section 1502.14(d), a "No-Action" Alternative must be considered. At the current time, an Integrated Natural Resource Management Plan (INRMP) finalized in 1996 has been implemented at the Arsenal. The No-Action Alternative would not immediately change management direction or the level of management intensity. Therefore, the Arsenal would continue to operate using the existing plan and management practices and would maintain current conditions. Although the No-Action Alternative would not result in the absence of any or all management activity, it would not address the Indiana bat, bog turtle, or habitat connectivity.

Alternative B, Targeted Resource Protection and Management: This alternative would address the issues at various management intensity levels. It would specifically target newer issues such as Indiana bat and bog turtle habitat, habitat connectivity on the landscape, and brook trout production for high intensity management. Other issues would receive less emphasis and would be addressed as resources allow. New information and requirements would be incorporated and it would fully comply with the *Sikes Act Improvement Act* and with Army Regulation 200-3 and DOD Instruction 4715.3. The different levels of management would also be integrated with other installation plans and with the military mission. This is the preferred alternative.

Alternative C, Maximum Protection and Enhancement: This alternative would address all the issues (new and old) to the maximum extent possible, subject to funding and personnel constraints. For some of the issues identified, it would provide enhanced protection over current levels or those proposed as part of the Targeted Protection and Management Alternative. This high intensity alternative would involve new initiatives to increase either species habitat or the populations of the species present on the Arsenal. It would fully comply with the *Sikes Act Improvement Act* and with Army Regulation 200-3 and with DOD Instruction 4715.3. It would be integrated with the military mission, but could have the potential to affect mission capabilities or expansion.

3.4 COMPARISON OF ALTERNATIVES

The table below compares the three alternatives in terms of how each alternative would address the issues identified through scoping and described in Chapter 1 of this EA. The desired future condition (DFC) is stated for each action alternative. For the No-Action Alternative, the current condition is described since that alternative anticipates no change in management actions or current conditions in the immediate future. Chapter 4, Affected Environment and Environmental Consequences, also describes the current condition in greater detail.

Objectives for each alternative are stated and are intended to achieve the desired future condition or continue the current condition. The action items listed for each alternative are essentially standards and guidelines (S&Gs) designed to achieve the objective and are therefore to be followed when managing resources. They are listed in order of priority. The S&Gs are cumulative and reflect the management intensity for each alternative. That is, the S&Gs for the No-Action Alternative would also apply to the Targeted-Management Alternative and the S&Gs for both those alternatives would apply to the Maximum-Protection Alternative. These are minimal or baseline guidelines and could be modified through adaptive management as new information is acquired.

COMPARISON OF ALTERNATIVES

Issues/Objectives	Alternatives		
	No Action Alternative A	Targeted Management Alternative B (Preferred)	Maximum Protection Alternative C
1. Potential loss of Indiana bat foraging habitat near hibernacula.	Current Condition: Overall habitat including wetlands is estimated to be good. Interior forest habitat is excellent.	Desired Future Condition (DFC): Areas within 5 miles of existing hibernacula are characterized by vegetation and foraging habitat that supports bats.	DFC: Habitat exists throughout the Arsenal that can support migrating and foraging bats.
Objective: a) Protect and conserve Indiana bat foraging habitat within the perimeter of the Arsenal. b) Support similar management actions by land managers outside the Arsenal to protect forage habitat of known hibernacula within a 5-mile radius.	<ol style="list-style-type: none"> 1. Determine bat habitat requirements. 2. Protect riparian and stream habitats from degradation: <ul style="list-style-type: none"> • Avoid potential habitat and stream alteration unless neutral or beneficial to species. • Preserve water quality to support the insect fauna that serve as food for the Indiana bat. • Protect vegetation along rivers and streams. 	<ol style="list-style-type: none"> 1. Closely regulate/minimize development in riparian areas. 2. Limit selective tree cutting to September through May. 3. Preserve forest cover along rivers and streams using bands of vegetation (closed canopy) at least 98 feet wide. 4. Prohibit timber harvest and firewood cutting in riparian reserves along stream banks except where catastrophic events such as fire, flooding, wind, or insect damage have resulted in degraded riparian conditions. 5. Establish 3/4 mile protective buffer zones around documented Indiana bat sites. All forest management, land use alteration or new mission activities will be reviewed by USFWS. 6. Inform and educate the public on the importance of bats (Environmental Awareness). 	<ol style="list-style-type: none"> 1. Improve habitat by manipulating and enhancing forest cover along brooks and streams using tree species associated with Indiana bats. 2. Create improved upland foraging summer habitat. 3. Monitor the habitat for foraging use.

Issues	Alternative A	Alternative B (Preferred)	Alternative C
2. Preservation of Indiana bat roosting habitat.	Current Condition: Potential roost trees are present, but have not been identified or protected. It is unknown whether roost sites exist. Bat population is unknown.	DFC: Indiana bats are assumed to roost within the Arsenal's boundary and potential roost sites have been identified and protected. Bat population is being maintained.	DFC: Habitat exists throughout the Arsenal, sites with roosting bats have been documented, and the bat population has increased.
Objectives: a) Protect or improve potential and existing Indiana bat roosting habitat and sites throughout the Arsenal. B) Maintain the existing bat population.	<ol style="list-style-type: none"> 1. Protect roost sites (and hibernacula) if found on the installation. 2. Retain large, dead trees that are potential nursery sites. 	<ol style="list-style-type: none"> 1. Conduct surveys to locate roost trees. 2. Protect and retain snags for roosting habitat. Snags will be defined for these S&Gs as any dead, partially dead, or defective live (cull) tree at least six (6) feet tall and at least six (6) inches in diameter at breast height (dbh.). 3. Designate no-cut areas around potential roost trees to avoid accidental damage. 4. Restrict firewood cutting to trees (dead or live) to six inches or less dbh, except that firewood gathering will be permitted: (1) in existing cull decks, (2) when thinning green trees (consistent with S&Gs), (3) to remove blowdown blocking roads, and (4) for fuel reduction where material poses a threat of catastrophic fire. 5. Visibly mark roost trees, as appropriate and if discovered. 6. Prohibit timber harvest within 250 feet of sites containing bats. 7. Provide additional protection for caves, mines, and abandoned buildings that might be used as roost sites for bats. 	<ol style="list-style-type: none"> 1. Establish buffer/no-disturbance zones around roost sites to protect the animals when they're using the area. 2. Restrict loud noise near roosts. 3. Census roosts to assess population numbers. 4. Conduct periodic surveys to locate additional roost sites and/or roosting bats. 5. Create potential roost trees by killing selected trees through girdling or herbicide application.

Issues	Alternative A	Alternative B (Preferred)	Alternative C
3. Potential loss of bog turtle habitat	Current Condition: Existing habitat has been identified and turtles have occurred historically. It is assumed that turtles currently are present.	DFC: Habitat is protected and maintained with characteristics capable of supporting bog turtles. Turtle population is being maintained.	DFC: Bog turtle habitat has been enhanced and turtles are documented to occur. The population has increased.
Objectives: a) Protect bog turtle habitat in the area of the 1987 sightings. b) Maintain the (assumed) turtle population.	<ol style="list-style-type: none"> 1. Maintain the hydrology of wetland bogs and fens that have the characteristics to support bog turtles by taking no adverse actions that would degrade the habitat. 2. Avoid stream channelization that would drain or flood the wetland or change its characteristics. 3. Avoid activities that could enhance successional growth, but allow natural succession. 	<ol style="list-style-type: none"> 1. Maintain a 300-foot buffer around the identified wetland (bog and/or fen). 2. Conduct surveys to determine population. 3. Prevent flooding of the habitat from beaver activity, but do not eliminate beaver activity if the characteristics of the wetland or fen depend on beaver activity. 4. Maintain the wetland characteristics of existing bogs or fens by preventing or retarding successional vegetation growth (trees) within the bog or fen using herbicides or mechanical methods. 5. Monitor herbicide and pesticide use in areas that could seep or drain into the habitat. 	<ol style="list-style-type: none"> 1. Do not construct new roads (motorized) that border bog turtle habitat. 2. Where possible, promote connectivity between small areas of wet vegetation and/or spring-fed bogs. 3. Prevent fertilizer, herbicide, and pesticide runoff from entering the habitat.

Issues	Alternative A	Alternative B (Preferred)	Alternative C
4. Impacts on state-listed wildlife	Current Condition: State-listed target species have been documented on the Arsenal. Populations and trends are unknown.	DFC: State-listed target species and associated habitats are being passively maintained.	DFC: State-listed target species have been surveyed and associated habitats are being protected or enhanced. Population trends and species have been determined and are increasing.
Objectives: a) Protect and conserve state-listed wildlife within the Arsenal boundary. b) Promote an increase in species populations.	1. Conduct field reconnaissance to better document species occurrence and habitat utilization with priority given to wood turtles (state Threatened), timber rattlesnake, bobcat, and piedbilled grebe.	1. Conduct limited surveys for species to find high priority sites for species management. Specific surveys prior to ground disturbing activities are not a requirement. Rather, the surveys will be done according to a schedule that is most efficient and sites will be identified for protection at that time. 2. Plot the type, extent, and location of species when found using GIS (or other database).	1. Conduct surveys within the known or likely ranges and habitats associated with the species. 2. Conduct surveys prior to the design or implementation of all ground disturbing activities. 3. Protect listed species as feasible where identified.
5. Ability of Upper and Middle Green Pond Brook to support brook-trout production (state designated).	Current Condition: State has designated Green Pond Brook above Picatinny Lake as trout-production waters. Upper Green Pond Brook produces brook trout and the Arsenal conducts a put-and-take program in the middle portion of the brook using non-native species.	DFC: Upper Green Pond Brook produces and maintains a stable population of brook trout. Middle Green Pond Brook has been established as a production segment and is capable of supporting brook trout.	DFC: Entire length of Green Pond Brook above Picatinny Lake produces and maintains a stable or expanding population of brook trout.

Issues	Alternative A	Alternative B (Preferred)	Alternative C
<p>Objectives: a) Maintain or enhance "production" of brook trout in Upper Green Pond Brook and establish a stable population.</p> <p>b) Restore production of brook trout in Middle Green Pond Brook.</p>	<ol style="list-style-type: none"> 1. Continue the "put-and-take" program to the extent that it is consistent with the goals for native brook trout. 2. Control herbicide and pesticide use to avoid adverse impacts to water quality. 3. Fell trees in riparian reserves only when they pose a safety risk. Keep felled trees on-site when needed to meet coarse woody debris objectives. 4. Cooperate with federal and state fish management agencies to identify and eliminate negative impacts associated with habitat manipulation, fish stocking, harvest, and poaching that threaten the continued existence and distribution of native fish stocks occurring on Army land. 	<ol style="list-style-type: none"> 1. Restore habitat that previously existed or habitat characteristics that are particularly suitable to sustaining viable brook trout populations: <ul style="list-style-type: none"> • Identify and attempt to secure in-stream flows needed to maintain riparian resources, channel conditions, aquatic habitat, and fish passage. • Manage streams to maintain high aquatic habitat complexity, stable stream flows, and channel stability. • Maintain cover and aquatic habitat complexity through in-channel woody debris, substrate, undercut banks, overhanging vegetation, and pools. 2. Do not exceed summer maximum water temperatures in streams being rehabilitated to provide brook trout habitat. 3. Meet the minimum standard for spawning substrate in brook trout streams and streams being rehabilitated to provide brook trout habitat 	<ol style="list-style-type: none"> 1. Discontinue the "put-and-take" program if necessary to enhance restoration goals for native species. 2. Stock native brook trout if necessary to increase or maintain the species viability. 3. Enhance brook trout streams by providing cover and high aquatic habitat complexity through in-channel woody debris, substrate, undercut banks, overhanging vegetation, and pools.
6. Biodiversity and habitat connectivity with contiguous areas outside Arsenal	<p>Current Condition: Habitat quality and species biodiversity are high. Arsenal is forested with large contiguous blocks of second-growth forest. Connectivity corridors have not been identified. Overall health is good despite degradation due to disease. Green Pond Brook and associated wetlands provide an aquatic corridor</p>	<p>DFC: Probable areas of connectivity have been validated and are maintained. Management activities are consistent with those of adjoining land owners and support species diversity. Unfragmented areas are being maintained. Forest health is improving and disease infestations are declining.</p>	<p>DFC: Habitat fragmentation has been reduced. Healthy, mature forest exists in large blocks and covers at least two-thirds of the Arsenal. Connectivity corridors have been prioritized and enhanced through water quality management activities and the use of silviculture techniques. The corridors support and sustain biodiversity.</p>

Issues	through the Arsenal. Alternative A	Alternative B (Preferred)	Alternative C
Objectives: a). Maintain habitat connectivity and management consistency with contiguous areas outside the Arsenal. b). Maintain or enhance species biodiversity and minimize habitat fragmentation within the Arsenal.	<ol style="list-style-type: none"> 1. Allow natural processes to continue. 2. Recognize existing right-of-way agreements, contracted rights, easements, and special use permits as valid uses. 3. Manage landscape areas where little mature forest persists to retain late-successional patches. 4. Provide for retention of old-growth fragments in watersheds where little remains. 5. Suppress wildfire, especially in riparian areas. 6. Allow salvage only for safety reasons along roads and near developed facilities. 7. Maintain open fields and permanent openings by periodic mowing or brush cutting outside of the songbird nesting season. 8. Monitor hemlock defoliation and mortality in riparian zones. 	<ol style="list-style-type: none"> 1. Protect unfragmented and dispersal habitat as appropriate for selected species. 2. Coordinate and integrate management activity and plans with other contiguous stakeholders or land managers. 3. Prepare a site-specific implementation plan prior to any habitat manipulation activities. 4. Develop existing managed stands to allow for continued connectivity in response to landscape changes. 5. Implement projects using established techniques, such as thinning and prescribed fire, provided that the objective is to protect or enhance forest, riparian, or aquatic habitats. 6. Restrict timber harvest to thinnings or other management activities. 7. Use prescribed fire to maintain or increase biodiversity. Allow treatments along roads and in urban interface areas. 8. Build no new roads in remaining unroaded portions of the Arsenal. 9. Maintain natural forest cover along riparian areas and ridgelines, thereby providing for wildlife movement and coarse woody debris recruitment and retention. 10. Maintain effective habitat continuity that allows for migration and genetic exchange of all species. 	<ol style="list-style-type: none"> 1. Restore natural forest cover along riparian areas and ridgelines, thereby providing for movement by certain species. 2. Improve habitat structural diversity that allows for migration and genetic exchange of all species. 3. Manage activities to promote restoration of landscape patterns that emulate historical variability 4. Consider converting roads to trails. 5. Reduce existing fencing. For each segment of new fence installed, remove an equivalent amount of fence in another location while considering high volume traffic areas that could endanger wildlife. 6. Reduce the existing system and nonsystem road mileage through decommissioning of roads. That is, for each mile of new road constructed, at least one mile of road should be decommissioned with priority given to roads that pose the greatest risks to riparian and aquatic areas, hydrology, water quality, and turtles. 7. Minimize construction of roads for silvicultural, salvage, and other activities. Where roads are necessary, design to mitigate impacts.

Issues	Alternative A	Alternative B (Preferred)	Alternative C
7. Potential increase in non-native plant species and invasives	Current Condition: Extent of non-native species is unknown. Mechanical means are used to remove or control autumn olive and other species on selected sites.	DFC: Non-native species and invasives that threaten T&E species have been eliminated on-site. Other species are being effectively controlled elsewhere as necessary.	DFC: All non-native species have been eliminated or effectively controlled.
Objectives: a) Eradicate non-native species in areas that could negatively impact T&E species and state-targeted wildlife. b) Control or reduce the amount and variety of non-native species throughout the Arsenal.	<ol style="list-style-type: none"> 1. Do not introduce non-native species onto the Arsenal as a general rule. If an introduction of non-native species is proposed, assess the impacts. 2. Any introduction should avoid retarding or preventing achievement of other natural resource objectives (such as protecting bog turtle habitat). 3. Continue to cull and treat autumn olive sites. 4. Use native species in developed or urban areas. 	<ol style="list-style-type: none"> 1. Survey the Arsenal to document and map locations and extent of invasive plants. 2. Evaluate current impacts of non-native species on plants that currently exist. 3. Develop management plans for eliminating or controlling non-native species. These will include an analysis of the impacts of implementing such programs on other species or habitats on the installation. 4. Include an assessment in all project planning (including habitat and ecosystem restoration and new construction) that determines the potential for new infestations. 5. Tier management plans for the control of noxious weeds to the <i>Pest Management Plan</i> and the <i>Integrated Natural Resource Management Plan</i>. 6. Treat known sites that threaten T&E species and where possible, use mechanical means to eliminate invasive infestations. 	<ol style="list-style-type: none"> 1. Treat all known sites and where possible, use mechanical means to eliminate invasive infestations.

Issues	Alternative A	Alternative B (Preferred)	Alternative C
8. Loss or deterioration of state listed plants (Endangered and Species of Concern).	Current Condition: State-listed plants discovered to date have been documented. The extent and locations of additional species are unknown.	DFC: Populations of state-listed plants remains constant. Management priority is given to "Endangered" species.	DFC: Populations of state-listed plants have been identified and all identified populations are increasing.
Objective: Protect and conserve state-listed plants within the Arsenal boundary.	1. Voucher and document photographically all Endangered plants or plant Species of Concern on a case-by-case basis as found or discovered.	1. Protect state-listed plants when identified. 2. Survey site-specific areas prior to ground-disturbing activities. 3. Use educational awareness programs to prevent destruction of species.	1. Systematically survey, identify, and plot species throughout the Arsenal. 2. Give the highest priority to management of identified or known species sites. Efforts must be undertaken to acquire information on these known sites and to manage this information so that it is available to all project planners. 3. Avoid ground-disturbing activities or chemical applications that could damage or destroy species.

Issues	Alternative A	Alternative B (Preferred)	Alternative C
9. Access to installation facilities and natural resources for outdoor recreation.	Current Condition: Arsenal is closed to general public. Dispersed outdoor recreation is restricted by mission activities. Hunting, fishing, and boating are allowed for designated personnel. Bird and hawk watching are also popular activities.	DFC: Continuation of the current condition.	DFC: Continuation of the current condition.
Objectives: a) Provide limited access for hunting and fishing that is consistent with natural and cultural resource goals, b) provide opportunities for sportsman within resource capabilities, c) avoid over-harvesting, and d) comply with established safety requirements.	<ol style="list-style-type: none"> 1. Continue hunting, fishing, and wildlife observation opportunities at current levels consistent with safety factors. 2. Manage hunting, fishing, and wildlife observation opportunities to minimize disturbance to plant and animal species. 3. Use educational awareness techniques to inform users about management strategies and user responsibilities. 4. Ensure consistency of recreational activities within riparian reserves with habitat objectives for the Indiana bat and bog turtle. 5. Perform routine maintenance of existing facilities. 	<ol style="list-style-type: none"> 1. Same as No-Action Alternative. Does not preclude future public use of developed facilities or areas as long as such uses are consistent with natural resource objectives and guidelines and safety regulations. 	<ol style="list-style-type: none"> 1. Same as No-Action Alternative. Does not preclude future public use of developed facilities or areas as long as such uses are consistent with natural resource objectives and guidelines and safety regulations.

4.0 CHAPTER 4 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter describes the relevant resource components of the existing environment and discloses the effects of each alternative presented in Chapter 3 on the pertinent resource or aspect of the environment. Consequently, it provides a baseline condition for each affected resource and is organized by resource component. Effects of a particular alternative or management action can be positive or negative, depending on the resource perspective and desired future condition. Effects can also be direct, indirect, and/or cumulative. Direct effects occur at the same time and place as the actions that cause them. Their causes are usually obvious. Indirect effects occur at a later time or different place than the actions that cause them. Their causes may not be obvious and may stem from impacts on other environmental elements. Cumulative effects are the combined effects of all actions, past, present, or future. Cumulative effects can be on-site (confined to the project area) or off-site. Effects on vegetation and habitat are chiefly on-site. Effects on water quality, wildlife, or fish are commonly off-site.

4.1 SETTING, HISTORY, AND MISSION

The Picatinny Arsenal is located primarily in Rockaway Township in Morris County in rural New Jersey. It lies within the New Jersey Highlands Region and Watershed Management Area #6. Appendix A provides descriptions of both areas. The map on page 56 indicates the location of the Highlands Region in relation to surrounding states. Newark, New Jersey is 32 miles southeast and New York City is 42 miles east of the installation. The Borough of Wharton (population 5,500) is located about one mile south, the town of Dover (population 15,000) is located about three miles south, and the Rockaway Borough (population 6,200) is five miles to the southeast of the installation. Freeways provide easy access to the major metropolitan centers of Newark and New York Cities. Many employees of the Arsenal also commute from eastern Pennsylvania. The Delaware Gap is 45 miles west on I-80.

The Arsenal dates from 1879 when the Congress of the United States authorized the purchase of 1,875 acres of land in Morris County for the establishment of a powder depot. Unofficially, it dates from the Revolutionary War when iron ore was smelted and further refined at the Mount Hope furnace to produce solid shot and other armaments for the Continental Army. In the Twentieth Century, the Arsenal continued to expand its production and land area. In 1902, Picatinny started shell loading and in 1917 began making powder for a wide range of munitions. Also in 1917, 56 acres of land were acquired and the Arsenal began producing smokeless powder and TNT.

A major expansion occurred during World War Two (1937 to 1944) when 2,910 acres were added to the installation. During the Korean War, the Arsenal again accelerated its production. After the war, the Arsenal became the US Army's research and engineering for nuclear and nonnuclear ammunition. Between 1955 and 1958, the Arsenal acquired an additional 572 acres by fee and placed restrictive easements on 639 acres of land adjacent to the Arsenal to create buffer zones. In June 1960, the Arsenal acquired another 784 acres from the Navy. This property, originally known as the Naval Air Rocket Test Station, is now called "Navy Hill."

Since the 1960s, Picatinny Arsenal has experienced a number of name and command changes. In 1977, it became the US Army Research and Development Command, a major subcommand of the Army Material Development and Readiness Command. In 1983, it became Armament Research and Development Center, an organization of the Army Armament, Munitions, and Chemical Command. In 1986, the Arsenal became Armament Research, Development, and Engineering Center (ARDEC). In 1994, ARDEC administration was transferred to the Army Tank and Automotive Command (TACOM).

4.2 DIRECT AND INDIRECT EFFECTS

4.2.1. Rare, Threatened, and Endangered Animal Species (Issues 1, 2, 3, 4, and 5)

Current Condition: Two federally listed endangered (LE) and two federally listed threatened (LT) animals are known to occur on the Arsenal. The Indiana bat (*Myotis sodalis*) (LE) is thought to depend on the habitat as a summer resident (Section 4.2.1.1). The bog turtle (*Clemmys muhlenbergii*) (LT) was sighted and confirmed in 1987 in the wetlands associated with the east branch of Green Pond Brook, but no sightings have occurred recently (Section 4.2.1.2). The bald eagle (*Haliaeetus leucocephalus*) (LT) is a transient species usually observed during migratory flyovers. Although suitable habitat exists in wetlands associated with Green Pond Lake, Denmark Lake, and upland ridges, stopovers are thought to be uncommon. However, raptors seen from the hawk watch site on the Arsenal hunt over much of the facility and area.

No federally proposed endangered or proposed threatened animals are known to occur at the Arsenal. However, four Species of Concern (two birds and two mammals) have been identified on the installation: cerulean warblers (*Dendroica cerulea*) and loggerhead shrikes (*Lanus ludovicianus*) are transient species observed occasionally during migration. A marginal population of eastern woodrats (*Notoma floridana*) formerly inhabited talus slopes along the southerly aspect of Green Pond Mountain. This former population is believed to be extinct. Recently discovered is the eastern small-footed bat (*Myotis leibii*).

Consequences:

All Alternatives

The effects of all alternatives are discussed below in the sections on Indiana bat, bog turtle, and state-listed species. Brook trout are discussed in the section on fish species. The bald eagle is not discussed since it is considered to be only a transient species that migrates through the area. There are no known nesting or breeding sites. Sightings have typically been during flight.

4.2.1.1. Indiana Bat

The main breeding and hibernating areas for Indiana bats appear to be associated with the major cavernous areas in the midwestern and eastern United States (Indiana, Kentucky, and Missouri). During the winter, approximately 85 percent of the entire population hibernate in only seven caves (Evans et. al. 1998). Indiana bats migrate between winter and summer habitats. In the winter they hibernate in caves (or mines). They enter the caves during early fall and continue to forage each night (Evans et. al. 1998). In the winter, when hibernating, Indiana bats form large, dense clusters of individuals. In late March and early April, colonies disperse and migrate to areas where they forage throughout the summer. Lack of adequate protection of the hibernaculum on private land immediately adjacent to the installation is a serious threat to Indiana bats in the vicinity of the Arsenal. No hibernaculum has been discovered on the Arsenal.

Current Condition: As indicated in Chapter 2, Indiana bat hibernacula exist on private land adjacent to the Arsenal. A survey of one hibernaculum, the Hibernia mine, counted 26 bats. Based on pre- and post-hibernation surveys, it is estimated that there are less than 50 bats in each of the hibernacula. Nevertheless, the Arsenal may provide roosting and foraging habitat as described in the following section.

4.2.1.1.1. Summer foraging habitat

Indiana bats are insectivorous. They forage primarily in closed canopy riparian woodlands or upland forests (Humphrey et. al. 1982). Optimal summer habitat includes mature trees that serve as roost sites and forage areas. Indiana bats prefer to forage around the crowns of large trees (Clawson 1987). Preferred stream habitat appears to consist of streams lined on both banks with mature trees that overhang the water by at least 10 feet.

Stream widths may vary from 10 to 70 feet. Typical forage areas consist of deciduous forest cover equal to or greater than 30 percent, with suitable roost trees located within about a quarter mile of the foraging area and permanent water available within about a third of a mile from the roost (US Army Corps of Engineers,USACE). The dominant overstory is normally comprised of trees that measure 9.8 to 23.6 inches diameter at breast height (dbh) (Evans et. al. 1998). Forest fragmentation that occurs when forests are cleared for farmland or urban development degrades bat habitat (Copyan 1997). The use of pesticides may pose a direct threat through poisoning or an indirect threat by eliminating food sources.

Consequences:

Alternative A

Avoiding habitat alteration unless neutral or beneficial to the bat would result in forest habitat continuing to grow and progress through succesional stages. Protection of riparian areas would likely prevent them from being degraded, however, there would be no improvement in the forest interior canopy structure or habitat along brooks or wetlands. Natural processes, such as increased understory, could degrade foraging habitat for the Indiana bat. Additional information would be obtained with regard to bat habitat requirements.

Alternative B

Regulating development in riparian areas and limiting tree cutting would provide increased protection for primary habitat. The buffer zones established along stream banks and around wetlands would enhance potential foraging areas. Potential foraging habitat would be maintained by restricting timber harvest and firewood cutting and providing information about the bat and bat habitat to the public.

Alternative C

Silviculture techniques would alter and improve suitable habitat in upland areas. Riparian and wetland areas would be treated the same as Alternative B, however, by emphasizing tree species associated with bats along brooks and streams foraging habitat would be improved over time. Removal or thinning of the understory and the resulting release of larger trees overtime would create a more open canopy and increase potential foraging areas.

4.2.1.1.2. Roosting Habitat

Adult female bats establish maternity roosts in hollow trees and under loose bark. Such trees may be located at varying distances from foraging habitat. Trees that possess tenacious bark that springs away from the trunk as the tree dies are optimal. Shade is also important to protect roost sites from intense heat, but ample solar insulation to maintain warmth beneath the bark is equally important. Areas with large trees and closed canopies are preferable. Although upland areas may be used extensively, maternity colonies appear to be formed mostly in riparian and floodplain forests near small to medium-sized streams (Clawson 1987). Bats have also been found along tree-lined ditches. Potential roosting habitat is destroyed or degraded by cutting large dead or dying trees (snags).

Consequences:

Alternative A

Snags would be retained, but there would be no effort to identify actual roost sites. If a roost site was discovered, steps would be taken to protect it. However, natural processes would continue and identification and protection would be random. Additionally, although a remote possibility, it might be necessary to retain and preserve old abandoned buildings if Indiana bats are found to roost in them.

Alternative B

Despite not having documented roosting sites within its boundary, habitat within the potential foraging area in the SE portion of the Arsenal would be protected. Curtailing or prohibiting selected timber activities and firewood cutting would maintain or increase potential roost sites. Surveys would be conducted to identify actual roosting sites. Given the emphasis on preserving snags, the potential roost sites would increase. Additional protection of potential and/or existing sites by establishing no cut zones, marking trees, and setting guidelines for snags would tend to stabilize the foraging and roosting bat population. Consultation with USFWS will be required for activities within protective buffer zones established around documented sites occupied by Indiana bats.

Alternative C

Conducting periodic surveys would provide more accurate information on the number of roosting bats and would document actual sites. As in Alternative B, potential roost sites would continue to increase. The bat population using the area for forage and roosting would likely increase. In order to establish buffer areas and restrict disturbance from noise, human (hunter) access to specified areas could be limited (at least seasonally) if sites were determined to be present. Both pedestrian and vehicular traffic could be curtailed depending on the location.

4.2.1.2. Bog Turtle Habitat

Bog turtles are normally found in small, discrete wetland habitats that are a mosaic of dry pockets, saturated areas, and areas that are periodically flooded. They depend on such a diverse pattern by using shallow water in the spring and deeper water in the winter. Bog turtles are semi-aquatic and are only active from April to mid-October (Copeyan 1997). They hibernate from October to April. Mating occurs in May and June and in June and July females deposit eggs in sphagnum moss or sedge tussocks (Copeyan 1997). Young turtles typically emerge in August or early September.

Habitat may be characterized by size of the area, degree of fragmentation, presence of invasive plants (non-native species), and extent of later-successional species. As open-canopy wetlands are transformed by woody vegetation, bog turtles may be forced to migrate from one wetland patch to another. Fire, beaver activity, grazing or flooding in periodic wet years could potentially disrupt successional growth and preserve bog turtle habitat. Extensive wetland fragmentation and roads adjacent to habitat pose serious threats to bog turtles.

Current Condition: In 1987, the NJ Division of Fish, Game, and Wildlife, Endangered and Nongame Species Office, documented the last official sightings of bog turtles in the middle of the expanse of wetland that occurs in the lower end of the east branch of the Green Pond shrub-swamp. There have been no documented sightings since that time. However, this site is believed to be marginally suitable and a minimal population may still exist given the site characteristics. Bog turtles usually inhabit shallow spring-fed fens, sphagnum bogs, marshy meadows, and pastures. They prefer areas that have soft, muddy bottoms with slow-flowing water and open canopies. They have been discovered in New Jersey in calcareous fen habitats (shrub and herb communities in low-lying areas where groundwater percolates over limestone bedrock). Ninety percent of bog turtle habitat in New Jersey is privately owned (Copeyan 1997).

Consequences:

Alternative A

This alternative would likely have a negative impact on habitat. Although activities would be avoided that increased successional growth, bog turtle habitat would likely be degraded over time as natural succession ensues. As grass or shrubland becomes dominated by early-seral trees, turtles could be forced to migrate to

other areas if such suitable habitat exists or is within range. Avoiding stream channelization or changing wetland characteristics may or may not maintain necessary characteristics

Alternative B

In order to prevent flooding of habitat, beaver dams would likely be breached and individual beavers or clans would likely be displaced. Woody vegetation would be deadened by appropriate means that would result in a net increase in herbaceous vegetation. Natural succession would thereby be reversed and the shrubland would revert to more of a meadow environment. Removal of beaver dams and the killing of seral vegetation as necessary would tend to stabilize the hydrology of the wetland. This in turn would maintain the turtle population to the extent that turtles occur. Maintaining 300 feet buffer areas would help to prevent inadvertent habitat damage or water quality degradation.

Alternative C

Actively promoting wetland connectivity and maintaining water quality would enhance bog turtle habitat and would support turtle populations by enabling turtles to migrate as natural conditions change. This would tend to sustain or increase the population depending on other natural factors. The turtle population would be surveyed and documented, and along with restrictions on herbicide use in designated areas, would protect existing populations. Restrictions on roads would help to reduce a major threat to turtles from vehicular traffic.

4.2.1.3. State-Listed Wildlife

Current Condition: A 1994 study of state and federal T&E species mapped the natural vegetative communities in an area that includes the Arsenal. In conjunction with that study, the state established priority protection areas. One such area was the Green Pond Mountain Macro site. This site includes part of the northern portion of Picatinny. Its boundary includes contiguous patches of forest and also the ridge, Green Pond, and Denmark Lake. It focused primarily on birds, but also tried to capture areas important for rare plants, insects, and animals, especially those associated with Picatinny Lake.

Ten New Jersey State-Listed Endangered Species are known to occur on the Arsenal: one snake, eight birds, and one mammal. Only four of these animals actually reside and breed on the installation: timber rattlesnake (*Croalus horridus*), Coopers hawk (*Accipiter cooperii*), red-shouldered hawk (*Buteo lineatus*), and bobcat (*Felis rufus*). The remaining six bird species may use installation habitats in a transitory manner. One waterbird, the pied billed grebe (*Podilymbus podiceps*) is listed by the state as "critically imperiled" and may nest and breed in the Denmark Lake shrub swamp.

Eleven state-listed threatened species are known to occur on the Arsenal: one turtle and ten birds. The most recent sighting of a wood turtle on the installation was documented in June 1999. Only three of the birds use the installation on a regular basis. The barred owl (*Strix varia*) resides and breeds on post, great blue herons (*Ardea herodias*) forage throughout the breeding season, and northern goshawks (*Accipiter gentilis*) nest and forages sporadically. The remaining seven bird species use a variety of installation habitats during seasonal migrations.

Consequences:

Alternatives A

Current population trends (increase, decrease, or stable) will likely continue. However, the trends are unknown on Picatinny Arsenal habitat. Field documentation would provide information for selected species such as the wood turtle, timber rattlesnake, bobcat, and pied billed grebe.

Alternatives B and C

There would be no incremental effects in the field or on the ground. Surveys and documentation would provide baseline data. Potentially positive effects would result from conducting surveys prior to ground-disturbing activities. Also, the plotting of species location would avoid unnecessary damage to associated habitats. If residency is documented, habitats would be protected or improved. In Alternative B, the protection of habitats once identified would increase species viability. Alternative C could have an incremental beneficial effect from more thorough surveying.

4.2.1.4. Fish Species

Current Condition: Fish on the Arsenal include warm and cool water species such as largemouth bass, chain pickerel, yellow perch, bluegill, pumpkinseed, bullhead, and lake chubsucker. The prime species fished for in lakes and ponds are largemouth bass, chain pickerel, Northern pike, crappie, yellow perch, catfish, and sunfish (INRMP Table 1.4.1.1, Section IV).

In addition, native brook trout (*Salvelinus fontinalis*) and some stocked trout are at home in the cold stream water on the installation. Brook trout is a state-listed species of "special concern." Natural reproduction of trout is rare in New Jersey (NJDEP 1998). A self-sustaining population can be found in the cold headwaters of Upper Green Pond Brook and other brooks and streams. The population in Green Pond Brook is considered to be a remnant of the original brook trout in the region. The natural habitat for brook trout can be either a stream or lake. They thrive in water with low temperatures and high oxygen content. Brook trout mature at about two years of age and spawn in the fall. Nests are typically constructed by the female on the gravelly bottoms of streams or lakes. Young trout feed primarily on insect larvae. Older fish eat an assortment of insects, worms, crustaceans and small fish.

Consequences:

Alternative A

Expansion of the brook trout population into the middle portion of Green Pond Brook would not likely occur given continuation of the current condition and continued stocking of trout. Also, breeding and spawning habitats are not likely to expand downstream. The population size and location would likely tend to remain static or could possibly decline. Increased danger of extirpation would also be possible, however, continued cooperation with state and federal fish management agencies would likely preclude loss of the species.

Alternative B

Controlling water temperature and maintaining stream flow, channel stability, and habitat complexity would likely expand the brook trout population into the middle portion of Green Pond Brook. This would increase species diversity in the middle portion of the brook and would tend to stabilize the trout population in the upper portion of Green Pond Brook. The threat of extirpation would be reduced.

Alternative C

Providing increased habitat, cover, substrate, and in-channel woody debris would likely increase the trout population in both portions of the brook. It would result in the temporary suspension of fishing in the brook and limitations such as catch-and-release only. That in turn could have a favorable effect on both stocked and native species.

4.2.2. Water Resources (Issues 3 and 5)

4.2.2.1. Hydrology and Water Quality

Current Condition: The Arsenal is situated in the "Highlands" area of New Jersey. Water is a major component of the Arsenal area as indicated by the presence of 18 ponds, four perennial brooks, and a number of intermittent runs, springs and seeps. Picatinny's ground water is part of the upper Rockaway aquifer. It is a key link in Farney Highlands Watershed Management Area 6 (Appendix A).

The Arsenal comprises 67 percent of the 9,600-acre Green Pond third order subwatershed. The headwaters of this drainage basin come from the 500-acre spring-fed lake known as Green Pond located just to the north and outside the Arsenal. This basin delivers water to the Rockaway River Subwatershed that is one of several drainages emptying into the Passaic River. Two main brooks flow into the installation from the north: Green Pond Brook and Burnt Meadow Brook.

The collection basin for the Arsenal is composed primarily of Picatinny Lake and Green Pond Brook. Picatinny Lake is approximately 6,000 feet in length, averages 1,000 feet in width, and encompasses approximately 115 acres (Powerhouse EA 1997). The lake is man-made with an average depth of 20 feet and contains approximately 165 million gallons of water. Green Pond Brook enters the lake from the north. It brings water from Burnt Meadow Brook and Denmark Lake, located to the north of Picatinny Lake. Picatinny Lake discharges water into the continuation of Green Pond Brook that continues through the Arsenal and discharges into the Rockaway River. As the main drainage through the installation, Green Pond Brook drains about 7,700 acres. Approximately 250 acres of the installation are drained via Ames Brook to the east into Ames Lake from a complex of brooks and runs that includes Gravel Dam Cove, 1500 Pond, Stillwell Pond, and G-2 Pond. This drainage area discharges into beaver brook subwatershed east of the installation.

At Picatinny Arsenal, there are three major regional water-bearing zones. They include a shallow unconfined aquifer, a confined aquifer, and a confined bedrock aquifer. South of Picatinny Lake, the bedrock and glacial sediments are divided into a sequence of six permeable layers and five intervening, low permeability layers. Green Pond significantly affects the groundwater flow in the area southwest of Picatinny Lake. Currently, there are three water supply wells in use at the Arsenal. All are located in the area southwest of Picatinny Lake and are screened from the confined aquifer (Powerhouse Environmental Assessment 1997). Picatinny Lake is a source of nonpotable water used for production-related purposes, including cooling of the powerhouse and for fire fighting. The lake is also the receiving water for stormwater discharge and for noncontact cooling water.

Consequences:

All Alternatives

No degradation of hydrology or water quality is anticipated. Protection of riparian areas and establishment of buffer zones would likely improve water quality by reducing sedimentation, reducing water temperature, and possibly reducing contamination from non-point sources. The Arsenal would continue to be an important link in Watershed Number 6 and the Highlands Region. Management actions would be neutral or beneficial to water quality.

4.2.2.2. Wetlands and Aquatic Habitats

Aquatic habitats include wetlands, lakes, ponds, and brooks. Most of these areas occur in proximity to still water (lentic) in lakes and ponds and moving water (lotic) in brooks and streams. These environments provide habitat for a multitude of fish and aquatic wildlife species, especially invertebrates that are important links in food webs at various trophic levels. The wetland trend of natural succession from herbaceous cover to more woody components is proceeding on the Arsenal. Wetlands also provide trapping, hunting and fishing opportunities.

Picatinny Lake provides habitat for warm water fish and waterfowl, including geese and ducks. Communities of fish survive in Picatinny Lake in part because of yearly stocking by the Arsenal. Fishing is considered an important amenity of the lake given its popularity with members of the Arsenal's rod and gun club.

Current Condition: Wetlands are scattered throughout the installation and contribute significantly to the biodiversity of the Arsenal. The Arsenal contains approximately 1,250 acres of wetlands (Bob Lichvar, pers comm 1994). Picatinny Lake is designated by both NJDEP and USFWS as an open water wetland. A few pockets of shrub or forested wetlands (palustrine) are located around the perimeter of the lake. A small forested wetland extending approximately 20 feet above the shoreline north of the powerhouse and dock area has been verified through examination of vegetation and hydrology. Here a wetland was created by runoff from adjacent slopes and two outfall structures. Soils data could not be obtained due to potential unexploded ordnance in the area. However, a Morris County soils survey has designated the area as "Urban Land." Extensive hydrophytic vegetation in the area includes emergent aquatic species such as Pickerelweed (*Pontedaria cordata*), bur reeds (*Sparganium spp.*) and clusters of Jack-in-the-pulpit (*Arisaema triphyllum*) mixed with jewelweed (*Impatiens capensis*), both wetland herbs, growing among trees in upland situations with aspen and white ash. In addition, there are 39 acres of wet meadow on the installation.

Consequences:

All Alternatives

No degradation of wetlands or aquatic habitats is anticipated. Protection of riparian areas and establishment of buffer zones would maintain or improve wetlands and associated habitats. Control of non-native plant species and habitat manipulation to protect the bog turtle and brook trout would also result in stabilized or improved conditions. Management actions would be neutral or beneficial to water quality.

4.2.3. Forested Habitat (Issues 1, 2, and 6)

The Arsenal is located in the New Jersey Highlands of northern New Jersey, a portion of the Reading Prong (Windisch 1993). The highlands are characterized by northeast to southwest trending ridges separated by long, broad valleys. The installation is contained in a wide, central valley approximately seven miles long. It also encompasses a narrower parallel intermontane valley (Green Pond Gorge) about two miles long. Both valleys are flanked by easterly and westerly ridges. The total width across the installation averages about 1.5 miles. The geology of the region produces a topography marked by an abundance of stones, boulders, and outcrops of bedrock.

Elevations on the Arsenal range from 685 to 1,287 feet. Elevations are generally lower to the south and east and higher to the north and west. The westerly ridge is Green Pond Mountain with summits ranging from 860 to 1,287 feet. The southern terminus of Copperas Mountain extends into the northern portion of the installation thereby separating the Denmark Lake Basin on the east from the higher Green Pond Brook Basin to the west. The easterly flank of the Arsenal is comprised of a series of knobs with summits ranging from 860 to 1,066 feet and local relief that ranges from 150 to 250 feet above Picatinny Valley.

4.2.3.1. Woodlands

Current Condition: The present status of the installation's forest is the result of ecological succession of land previously farmed or cleared as well as more recent selective logging. Approximately two-thirds or 67 percent of the Arsenal is wooded. Most of the wooded portion is in second-growth stages having been logged historically. The installation's woodlands are representative of the forest types of the Highlands Region (Leck 1975). Forest types on the Arsenal include mixed oak, hemlock, red maple, and northern hardwoods. Forested areas occur on ridge tops, slopes, and portions of the Picatinny Valley. The woodlands on the installation are

categorized into two groups: palustrine forests and upland forests (terrestrial forests). Palustrine forests are commonly referred to as swamps or riparian corridors and arise from and cover wetlands (Breden 1989). Upland forests arise from and cover terrain that lacks soils and hydrology characteristic of wetlands. The recognized cover types of palustrine and upland forests on the installation are listed in INRMP Table 3.4.1.1, Section I. In addition, a significant expanse of palustrine shrubland occurs in the north end of Denmark Lake. There are no areas on the installation that can be classified as original grassland.

The upland forests on the installation are mixed oak and northern hardwood. The palustrine forests are comprised of red maple (*Acer rubrum*), Hemlock (*Tsuga canadensis*), and aspen/birch (*Populus/Betula*). The mixed oak type is the most widespread and prevalent. Most of these stands are in pole-sized growth stage. Species composition varies with elevation, soil conditions, site quality, and past management history. As a general rule, stands at lower elevations are dominated by species from the red oak group while stands at higher elevations are dominated by species from the white oak group. However, most stands on the Arsenal have species from both the red and white groups.

The northern hardwood forest type varies widely in species composition and can include upward of 20 species of trees. The single most common species is sugar maple (Nyland et al. 1981). Approximately 15 percent of the installation's forests are composed of this hardwood forest type. Most of these stands are located in the valley and eastern ridge of the installation. The red maple forest type consists of almost pure red maple. Most stands are located on moist or saturated soils. The red maple stands on the installation are a local climax forest. Approximately 20 percent of the woodlands consist of this type.

Hemlock occurs on the installation in pure stands and also to a lesser extent in northern hardwood and mixed oak stands. The hemlock stands are the only coniferous forest type located on the Arsenal. Currently, hemlock is concentrated in the valley at one location. Several of the hardwood stands have a hemlock understory.

Consequences:

Alternative A

There would be no change in the types of species present in the immediate future. Suppression of wild fire and minimal salvage would contribute to continued succession, but the forest would move slowly toward a mature or old-growth condition. Shade tolerant species (maples) in the understory would likely increase, but shade intolerant species (oak) would decrease without disturbances to the ground and canopy.

Alternatives B and C

There are no anticipated effects on the types of forest species although the seral stages could change in selected areas. Portions of the forest may become less monotone and more of mixed species and age across the landscape over time. The use of prescribed fire and management of existing stands would improve structural diversity and enhance connectivity. Coordination with adjacent land owners and managers would result in management actions that could increase dispersal habitat, create forest openings in selected areas, and improve connectivity. Impacts to wildlife biodiversity and forest connectivity are discussed under Wildlife in Section 4.2.4. In Alternative C, the reduction of roads in selected areas would provide potential mobility for a variety of species.

4.2.3.2. Insects and disease

Insects and diseases are a natural part of the forest ecosystem. Human activities have changed forests by introducing insects and diseases. Activities that changed plant species composition, tree density, canopy structure, and created a patchwork pattern of different stand ages have all contributed to responses by insects and diseases that were outside their historic range. If kept within endemic levels, i.e., levels that would be expected for a given stand age and forest type, the actual increase in the incidence of insects and disease is part of the inherent value of mature habitat. Pathogens present in the forest create trees with hollow boles, heart rot, dead

tops, multiple leaders, and witches brooms. Although these traits traditionally detract from the economic value of a stand, they also increase biodiversity by maintaining habitat for a wide variety of species: den, nest, rest, and forage. Part of the ecological role of forest pathogens is providing for adequate snag and coarse woody debris recruitment. This structure, in turn, supports categories of wildlife species that aid in dampening the cyclic nature of insect outbreaks. Likewise, the death of individual or small patches of trees creates openings that allow for additional diversity in forest structure.

Current Condition: As indicated in the Highlands and Watershed Management Area 6 descriptions (Appendix A), the hemlock wooly adelgid (*Adelgas tsugae*) and elongate hemlock scale (*Fiorinia externa*) are currently decimating mature hemlock trees. It has been estimated that 80 to 95 percent of the trees are dead or dying (NJDED). Currently, no other major disease or infestation problems are evident. There have been no recent gypsy moth outbreaks.

Consequences:

All Alternatives

Anticipated management actions in any of the alternatives would not likely substantially affect the incidence of disease (wooly adelgid) in hemlock. Nevertheless, hemlock mortality remains a concern. Since hemlock often grows along streams, rivers, ponds, and lakes, the loss of hemlock could significantly impact habitat and water quality. Hemlock mortality could cause changes in energy and nutrient inputs to streams with hemlock riparian buffers. Defoliation would likely result in higher water temperatures that in turn will likely cause increased in-stream nitrogen and phosphorous levels. High in-stream temperatures could also cause increased native brook trout mortality.

Consequently, hemlock mortality will be validated and monitored. Thinnings of the understory to produce higher canopy and larger trees (to improve bat foraging habitat) would tend to increase tree vigor and health and could thereby retard the effects of disease. Monitoring and surveillance for gypsy moth will also continue.

4.2.4. Wildlife (Issues 6, 8, and 9)

4.2.4.1. Nongame Species

Current Conditions:

Vertebrates

The Arsenal's fish and wildlife community is representative of the fauna of the northeastern area of the US. Faunal diversity on the installation is better than average for North Central New Jersey. Over 300 species of vertebrates are known to occur on the arsenal. The list of vertebrates includes: 26 fish species, 21 amphibian species, 19 reptile species, 208 species of birds, (approximately 169 are migrants), and 41 species of mammals (INRMP Tables 1.4.2.3 and 1.4.2.4, Section IV). At least 23 additional species of invertebrates have the potential to occur on the installation. The large number of vertebrates on the Arsenal is in large part due to the diverse array of habitat that includes dry forested ridge tops, talus slopes, bottomland hardwoods, mesophytic wetlands, conifer stands, old fields, riparian sites, shrub stands, wetlands, brooks, ponds, and lakes.

Herptofauna: Amphibians and reptiles help to control insect and rodent populations and serve as a forage base for other wildlife. Common amphibians and reptiles on the installation include: red spotted newt, Green frog, bullfrog, American toad, eastern painted turtle, snapping turtle, garter snake, and black rat snake. Table 1.4.2.2, Section IV in the INRMP lists the amphibians and reptiles known to occur on the installation. Although the present inventory is fairly complete, information on the distribution patters and habitat requirements remains sketchy.

Birds: The species of birds on the installation are diverse. They include permanent residents, summer breeders, winter residents, and migrants that only pass through during spring and autumn. These species vary in their foraging preferences as herbivores, frugivores, granivores, insectivores, omnivores, predators, and scavengers. Habitat preferences are similarly diverse and include urban lands, forested lands, wetlands, and grasslands (Chambers 1983, DeGraff et al. 1980). Table 1.4.2.3, Section IV in the INRMP lists the 208 species of birds known to occur on the installation. This list is based in part on a statewide breeding bird survey sponsored by the NJ Audubon Society and is thought to be essentially complete.

Of the 208 recorded species, 39 are considered permanent residents, 64 summer residents, and seven winter residents. The remaining 98 migrants "pass through" with occasional stopovers and incidental visits. In addition, out of the 103 species inhabiting the Arsenal during the breeding season, 65 are confirmed breeders and another 15 are probable breeders. The number of regularly occurring species recorded for New Jersey is 350 (Rich Kane, pers comm 1995).

Chiroptera (bats): Nine species of bats, all in the super-family Vespertilionidae, have ranges that include northwestern New Jersey (Humphrey 1982). Seven of these, all small-bodied insectivores, have been documented on the installation. The little brown bat (*Myotis lucifugus*) is probably the most common bat species on the Arsenal. An historical discovery of a female Indiana bat (*Myotis sodalis*) was made in July 1995. The trapping effort was the result of an environmental assessment process for a requested grant of easement by Mount Hope Hydropower Inc. This summering resident was the first Indiana bat documented in New Jersey or the northeast US in decades. In the winter and spring of 1993, hibernating Indiana bats were discovered in an abandoned mine about two miles from the Arsenal. The following year (1994), two more Indiana bat hibernacula were found in abandoned mines with a half a mile of the installation. As a result, an Endangered Species Management Plan is being prepared for the Indiana bat at Picatinny Arsenal in accordance with Army Regulation 200-3. Section 4.2.1.1 discusses Indiana bat habitat requirements.

Other Mammals: Other mammals on the Arsenal include small nongame types such as insectivores (moles and shrews), and rodents (mice and voles). The populations of these small species collectively provide a major forage base for most of the installation's predators. The most common of these animals are the white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), and short-tailed shrew (*Blarina brevicauda*). Table 1.4.2.4, Section IV in the INRMP lists the 41 species of mammals known to occur on the installation.

Invertebrates

Odonata Species: Table 1.4.2.1.1, Section IV in the INRMP lists the invertebrates known to occur on the installation. These species include: 63 dragonflies, 31 damselflies, 44 butterflies, and 150 moths. Odonata species serve as an indicator species for water quality and/or subtle changes in habitat. Odonata diversity on the installation is exceptional. It represents more than half the number of known species in any other state or province in North America (Carle 1995). There are 27 different microhabitat sites on the installation which support such microinvertebrates. For example, the rare New England bluet (*Enallagma laterale*) is a federal Species of Concern. The global range of this species in the northeast US contains only about 40 sites. The largest population (several hundred to a few thousand) occupies portions of Denmark Lake.

Lepidoptera Species: Table 1.4.2.1.2, Section IV also lists the butterflies and moths known to occur on the installation (194 species). Observing butterflies with binoculars is becoming an increasingly popular nature activity. From 1991 to 1995, an informal survey identified at least 150 different kinds of moths. There are undoubtedly others that occur.

4.2.4.2. Game Species

Terrestrial game species are categorized into small game and big game animals. Small game species are further categorized as waterfowl, upland game birds, and upland game animals.

Waterfowl: The waterbird community provides recreation for hunting and viewing. Waterfowl species include: wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), green winged teal (*Anas carolinensis*), black duck (*Anas rubripes*), Canada goose (*Branta canadensis*), and others. In addition, waterbirds such as coot (*Ful. americana*), common moorhen (*Gall. chloropus*), Virginia rail (*Rallus bilimicola*), and sora (*Porzana carolina*) are present and can be hunted. Hunters must obtain permits and comply with state and federal hunting regulations.

Upland Game Birds: Native upland game birds on the Arsenal include: wild turkey, ruffed grouse, American woodcock, and ring-necked pheasant. However, pheasant do not maintain viable populations in northern New Jersey. Pen-reared ring-necked pheasants are seasonally stocked on the installation for put-and-take hunting. Through 1988, approximately 600 birds per year were stocked. Recently, stocking has increased to about 1,300 birds per year and the stocking season has been extended. Also, in New Jersey, the morning dove does not have game bird status and is protected as a songbird. Grouse and woodcock hunting provide limited recreation on the installation, but populations are low due to the lack of early-successional habitat.

Upland Game Animals: Mammals that may be pursued as small game on the installation include gray squirrel and eastern cottontail. Woodchucks are also present and typically den and forge in close proximity to developed areas. In addition, fox, raccoon, and opossum are present and can be taken during the small game season.

Big Game: Two species of big game occur on the Arsenal: white tailed deer and black bear. The deer herd provides consumptive and nonconsumptive recreation. White tailed deer are the only animals hunted on post. There is no open season for black bear. Although individual black bears and sows with cubs are routinely observed on the installation and the installation provides habitat for bears, the habitat and size of the area is insufficient to support a self-sustaining population (Hendee et al. 1978). The Arsenal functions mainly as a travel corridor between winter dens and summer ranges.

Consequences:

Alternative A

The forest and woodlands would continue to move successionally toward old growth or climax conditions. The ecotone situation that would tend to result may not match with the surrounding land areas or provide habitat for different species. This could create a mismatch between various types of habitat and the current wildlife species. It would also have the potential to disrupt migration corridors. As a result, Picatinny Arsenal could become an isolated ecosystem. The effect on biodiversity of species is unknown, but would be largely influenced by happenstance. To the extent that populations would become isolated within the Arsenal, the potential for extirpation of species would increase. There would likely be no immediate effect on game species. However, there could be longer-term effects since deer, for example, prefer younger forests in early stages of succession to mature forest.

Alternative B

Maintaining riparian, grassland, and forest connectivity would protect species diversity. Restricting harvest activities, maintaining unroaded areas, and protecting dispersal habitat would minimize fragmentation of forest and other habitats. Unfragmented interior forest would continue to support certain neotropical migrants and/or the 208 species of birds known to occur on the Arsenal. Management and silviculture activities would be consistent with land management areas outside the Arsenal boundary further enhancing habitat connectivity throughout the larger region. Human animal interaction would also be less likely to occur (i.e. road kills and nuisance situations). There would be no immediate impact on game species, however, to the extent that various

habitats remain intact and support migration, game populations would likely increase given the general improvement in habitat connectivity, the protection of riparian areas, and retention of old-growth and interior forest.

Alternative C

Restoring the historical landscape patterns would help to preserve biodiversity. Restoring or enhancing forest cover along riparian areas (to include developed portions of the installation) would increase connectivity. Species diversity would be enhanced as natural forest cover and landscape patterns were restored. There would be anticipated changes in the patterns of home ranges and habitat utilization by some species. Restrictions on roads and fences would reduce fragmentation and thereby improve the quality of forest interior habitat. Improving habitat structural diversity would also enhance biodiversity. Game populations would likely increase to the extent that connectivity, structural diversity, and forest cover are restored. This alternative could impact mission capability by restricting expansion of facilities, especially those not located in the current developed cantonment area.

4.2.5. Vegetation (Issues 7 and 8)

4.2.5.1. Non-Native Plants (Noxious Weeds)

Non-native plants may take the form of noxious weeds. Exotic plants that colonize disturbed habitat or invade undisturbed native plant communities are considered noxious weeds. They often have no predation from insects and/or diseases. Many non-native plants or "weeds" are very persistent, can spread very rapidly, and may displace native species indefinitely. Noxious weed populations, once established, tend to expand at an exponential rate. Noxious weeds out-compete and replace native species thereby reducing biodiversity. Forage is often reduced for wildlife since nonpalatable noxious weeds replace palatable native plant species.

Current Condition: A complete inventory of the Arsenal has not been conducted for non-native plants. However, several species have become problematic. These species include: common reed (*Phragmites australis*), Japanese knotweed (*Polygonum cuspidatum*), garlic mustard (*Brasica. rapa*), multiflora rose (*Rosa multiflora*), Japanese barberry (*Barberis thunbergii*), and autumn or Russian olive (*Elaeagnus angustifolia*). Autumn olive, for example, has become increasingly evident and in at least one instance has replaced open-forest grassland of several acres with dense shrubs and early-seral trees. Other non-native species are likely to be present. Table 3.4, Section I in the INRMP lists plant species that are known to exist on the Arsenal. A list of non-native plants is currently being developed by the state of New Jersey.

Consequences:

Alternative A

Natural changes would continue to occur resulting in incremental encroachment of invasive species over time. Although the precise effects are unknown, there would be a likely decrease in species diversity as "invasive" plants eliminate native species. This would be especially dramatic in wetland areas, common reed invades and replaces natives. Species such as the bog turtle and those that utilize meadows and grassy areas could be highly impacted. Elimination of native grasses and meadows would especially impact grassland species of birds. Human activity would increase the opportunities for non-native species to be transferred to new areas because no assessments would be conducted and known sites would not be treated.

Alternative B

Endangered and Threatened species would have increased protection by the elimination of invasive infestations that potentially threaten them. Control and/or eradication of non-native species on the Arsenal would also

increase or maintain species diversity by making replacement of native species by noxious weeds more difficult. The general condition of animal habitat would likely improve. Current wetland and meadow habitats would be maintained. Endangered species habitat (both animal and plant) would be protected as identified. Surveys would have the indirect effect of avoidance of inadvertent destruction of native Endangered species. Assessments prior to ground-disturbing activities would reduce the potential for noxious weed infestations.

Alternative C

The more precise and aggressive management of known sites and the additional information gained from surveys would result in an increase in native vegetation and a reduction in non-native species. This would represent an added improvement over other alternatives. However, the alternative would substantially increase costs.

4.2.5.2. State-Listed Plants

Current Condition: There are seven state-listed endangered plants on the installation, four of which are aquatic species found in Denmark Lake: Featherfoil (*Hottonia inflata*), Robbin's pondweed (*Potamogeton robbinsii*), small bur (*Spartanium minimum*), and lesser bladderwort (*Utricularia minor*). Slender wood reedgrass (*Cinna latifolia*), meadow horsetail (*Equisetum pratense*), and large leaved holly (*Ilex montana*) are associated with wetlands. There are seven other state-listed endangered species that are potentially present and 14 or more "Species of Concern." New Jersey lists plant Species of Concern and monitors status through the Natural Heritage Program. Most of these plants occur in the remote northern portion of the Arsenal (Green Pond Mountain Macro site). Few, if any, Species of Concern are expected to actually occur on the Arsenal (Rick Radis, pers comm 1993). Six other species are ranked by New Jersey as imperiled. Table 3.4.5, Section I in the INRMP lists those plants known to exist on the Arsenal that are listed by New Jersey as either endangered or of conservation concern. No federally Threatened or Endangered plants are known to exist on the installation.

Consequences:

Alternative A

Natural processes would continue. The direct effects from human activity and development would be the additional loss of species and populations. The photographic documentation would provide limited protection for those plants or sites identified. However, the identification of plants would not be systematic or comprehensive.

Alternative B

Using site-specific surveys prior to ground-disturbing activities would encourage the survival of state-listed plants, especially for those species considered to be Endangered. Site surveys would prevent the inadvertent destruction of plants. Since the majority of the plants are aquatics, preservation of water quality would enhance state-listed populations. The additional public information provided would also help prevent the inadvertent destruction of plants of conservation concern.

Alternative C

Better information and data obtained through systematic surveys would provide added protection. Avoiding detrimental activities or the use of chemicals and herbicides in areas identified as having state-listed plants would likely prevent destruction of existing plants. Management of known sites would likely increase the populations.

4.2.6. Socioeconomic Factors (Issue 9)

4.2.6.1. Outdoor Recreation

Current Conditions:

General Recreation

Given its long-standing mission and the possible presence of unexploded ordnance, most outdoor recreational activities are confined to limited areas. A small area is set aside for camping near the Denmark Lake picnic and ballfield area. No areas are designated for intensive winter or water sports. Ice skating is permitted on South basin Pond when conditions are safe. Swimming is not permitted in any of the natural lakes or ponds on the Arsenal. Limited bicycling and jogging routes and fitness courses have been established along roadways and railroad beds. A trap/skeet range and an archery range are managed and maintained by the Rod and Gun Club.

In addition to the general recreation areas, there are natural environment, special interest, botanical, geological, and designated historical areas. All areas that could be designated for dispersed recreation activities are severely restricted by mission activities. Hiking, climbing, and bird watching, for example, are limited to off hours and weekends when testing is not being performed. Botanical areas are comprised of probable critical habitat for wildlife. A few of the noteworthy botanical areas are: Gravel Dam Cove and the eastern shoreline of adjacent Denmark Lake, Denmark Lake shrub swamp, upper Green Pond Brook wetlands, and Green Pond and Copperas Mountain ridgetops.

The rocky terrain and steep slopes on the western portion of the Arsenal are noteworthy geologically as well as for the microhabitats that are represented. Picatinny Peak is one of the distinctive landmarks. Other geological areas include the rock outcrops and cliffs of the western ridges; the Gorge and other talus slopes; and the 670, Gorge, and Copperas Overlooks. The major historical area on the installation is Walton/Doland Cemetery. It is a pre-Revolutionary War family cemetery used by the early settlers of the Mount Hope District of Morris County.

Hunting

The Picatinny Arsenal is not open to the general public and is considered to be a closed post. Due to the 1926 explosion and continuous testing, the landscape poses an unacceptable safety risk and consequently recreational hunting and fishing privileges are not extended to the general public. Although the general public is excluded from the installation, hunting, fishing, and trapping privileges are extended to select personnel: active and retired military, disabled veterans, and civilian personnel employed or retired from the installation.

The ARDEC Regulation 200-1, dated 5 June 1996, sets forth the rules by which sportsmen must adhere concerning safety and security precautions. This regulation is designed to ensure that there is no conflict between sportsmen and the Arsenal's military mission. It also imposes "conditions and constraints" on users of the Arsenal's hunting areas to ensure their safety and the safety of others. Close coordination is required with mission activities as hunting areas are closed during testing or energetics operations. Education of the Picatinny community is accomplished by dissemination of clearly stated rules (ARDECR 200-1) to sportsmen and mandatory annual hunter safety briefings.

The Picatinny Arsenal Sportman Map provides an overview of the fish and wildlife management areas. The forested land is where most of the big and small game hunting is permitted. Approximately 4,700 acres are available for hunting, of which 360 acres are available for waterfowl shooting. Fishing is permitted on two lakes and eight ponds, totaling about 392 acres, as well as two brooks. Nonconsumptive recreation uses associated with wildlife (viewing) exist on much of the installation's land.

Small game hunting season on the Arsenal extends from late September through late February (120 days). Small game that may be hunted includes: waterfowl, rails, upland game birds (especially pheasants), and upland game

animals. Turkeys can be hunted during the spring gobbler season that runs from late April through late May (24 days). Big game hunting seasons for white tailed deer extend from late September through mid-January. The six NJ deer seasons are: open Fall bow (36 days), permit bow (19 days), firearm (6 days), permit shotgun (1 to 2 days), permit muzzleloader (18 days), and open winter bow (31 days). In addition, trapping opportunities exist on the installation for terrestrial and aquatic furbearers. The trapping season runs from mid-November through early May. Few people pursue this activity.

Fishing

Open water fishing occurs ten months out of the year and ice fishing occurs for approximately two months. Anglers can select from fishing for warm/cool water fish or cold water species. Recreational areas suitable for fishing include lakes, ponds, and streams; however, the most popular fishing areas are a result of a trout-stocking program. Three stockings per year are made totaling approximately 7,000 trout.

Consequences:

Although public access may be highly desirable, human access can have negative effects. Providing access for hunting and fishing, for example, may cause a number of potential problems such as damage to sensitive habitat, non-point-source pollution of streams and wetlands, and human and noise impacts on wildlife. Roads or trails may also serve as barriers to certain species and organisms and provide a friendly environment for transmission and growth of noxious weeds (non-native plants).

Alternative A

There would be no change from the current condition. However, positive effects would accrue from the educational awareness activities and minimizing disturbance to select plant and animal species. For some species such as deer, hunting would be an effective management tool for controlling the population. The protection of riparian areas and potential roost trees would prevent negative effects on Indiana bats. Bog turtle habitat characteristics are such that they provide a natural barrier to human intrusion. Current restrictions and controls would keep impacts to a minimum. Further reductions or restrictions of activity would be based on safety concerns. The possible exception could be fishing if it would become necessary to suspend activity or the put-and-take program.

Alternatives B and C

Same as Alternative A, except that more aggressive management of brook trout habitat in Alternative C could possibly result in the elimination of the put-and-take fishing program.

4.2.6.2. Land Use

Current Condition: Approximately one-third of the Arsenal consists of urban land. The improved and semi-improved grounds are the areas where most of the human activities occur. The Arsenal contains research and development facilities, a central powerhouse, recreational facilities, and residential and institutional buildings. In addition to ARDEC, Picatinny has several other tenant (DOD) organizations and hosts a score of private contractors that work on the installation. From a peak workforce of about 18,000 people in 1942, the numbers have steadily declined. The present federal workforce is approximately 4,500 of which about 75 percent work for ARDEC. By the year 2000, the workforce is expected to shrink to less than 3,800 people.

Consequences:

All Alternatives

None of the alternatives would impact current land use. Expansion of current uses or facilities outside the presently developed areas is not anticipated. However, Alternative C would likely restrict future development of expansion beyond those areas currently developed. None of the alternatives would increase or decrease the workforce. There would be no effects on current facilities.

4.2.6.3. Cultural Resources

Current Condition: A cultural resource survey in 1994 identified individual structures and groups of structures as eligible for the National Register of Historic Places. One such structure is the powerhouse (Building 506). The powerhouse is considered historically significant because of its association with the Powder Factory Area (1880 to 1906) and its construction. The powerhouse was built in 1906 as a coal burning facility that produced electricity and steam, using Picatunny Lake as a water resource. Coal bins and hoppers served by a railway line brought anthracite coal to the powerhouse. A Cultural Resources Management Plan designates several historic districts for protection / restoration.

Archeological field sites contain primarily settlement period features and artifacts. Examples of these are rock fences, early roads and railroads, home sites, dumpsites, cisterns, forge remnants, and iron mine tailings. In 1993, remnants of an old earthen dam forming a millpond for a former sawmill were discovered. Few, if any, American Indian artifacts have been found on the Arsenal. Although rock shelters are present in the area, there is no evidence of pre-settlement use.

Consequences:

All Alternatives

None of the alternatives would affect cultural resources.

4.2.6.4. Forest Products

Current Conditions: The most recent forest (timber of forest products) management plan was prepared in 1974. This plan described the amount of forested land on the installation, timber volume information, the silvicultural treatments to be employed, forest types and species to be managed and the fire protection program. Forest land classes were used to categorize and characterize the accessibility or productivity of timber resources for harvest. The installation's acreage is divided into commercial and noncommercial forest categories. The Arsenal's forests are primarily in pole-sized growth stages. However, the production of pulpwood is not considered a viable option in this region because of the absence of local pulp mills and the current world economy. In 1983 to 84, a timber cruise was conducted in order to update the 1974 woodland management plan. The acreage of woodland comprised of each forest type was not calculated in the 1983 to 1984 cruise and stands were not delineated. From 1988 to 1990, an installation-wide inventory was conducted. That inventory estimated potential merchantable volume of forest products to be 22.5 million board feet (INRMP). Timber products produced from the Arsenal's forests include saw logs and firewood.

Consequences:

All Alternatives

Due to both limited acreage of commercial forest land, as well as multiple use management values and objectives, timber harvests will continue to be occasional and infrequent. Discovery of the Indiana bat (*Myotis sodalis*) and development of an Endangered Species Management Plan will likely affect timber harvests in future years. Timber sales or harvest would likely be restricted to silvicultural treatments, such as thinning, for the purpose of improving habitat conditions or improving safety. The best opportunity for timber harvest and sales in the immediate future may be for fuel wood, subject to limitations and standards and guidelines. However, the installation's forest will not likely be managed in the future as an industrial forest for maximum timber production.

4.3 MITIGATION

Mitigation typically involves elimination, minimization, or compensation for impacts if unavoidable. Implementation of an INRMP to manage the natural resources of Picatinny Arsenal is a positive action that essentially has no adverse effects. It provides a broad range of benefits while maintaining the the Arsenal's and ARDEC's ability to meet mission requirements. Through the implementation of an active, integrated planning process, the management goals and programs that comprise the INRMP have been adapted and modified to avoid and minimize adverse impacts. In this way, mitigation measures are incorporated into the preferred alternative. Consequently, there is no requirement for compensatory mitigation.

4.4 CUMULATIVE EFFECTS

Alternative A

Natural processes would continue. Cumulative effects would tend to be negative in that habitat characteristics would likely change to the detriment of Endangered Species or Species of Concern. Continued seral development (vegetation growth) in the wetlands associated with the bog turtle would reduce the ability of the habitat to support turtles. Although the overall interior forest habitat would likely remain very good, the movement toward mature conditions with increased understory could reduce the quality of bat foraging habitat. Roosting habitat might improve as larger trees died and became snags. Invasive plant species would likely increase, possibly reducing populations of state-listed plants and Threatened and Endangered animal species to the extent that such species depend on native vegetation. Invasives would further reduce plant species biodiversity. Grassland areas would also be reduced through succession of non-native plants. In addition, connectivity and species biodiversity throughout the Arsenal and surrounding area would likely be reduced as changes outside the Arsenal boundary produce disconnected islands of habitat.

Alternatives B and C

By design, both alternatives would follow an integrated ecosystem approach and would incorporate existing installation planning documents and management plans. The revised INRMP would also further establish or continue existing partnerships with federal, state, and local agencies and organizations. Coordination with adjacent land managers would also be enhanced. Consequently, there would be a reduced possibility for negative cumulative effects arising that are not already considered in the proposed revision. The positive effects are discussed in the previous resource sections. The INRMP programs and standards and guidelines would have the cumulative effect of enhancing environmental quality, improving connectivity, and protecting species, especially the Indiana bat, bog turtle, and brook trout. Associated monitoring would contribute to a reduction in negative cumulative effects through adaptive management. Surveys would provide additional information and help to establish baseline data. New information and relevant issues or initiatives identified, either on or off-post, would be incorporated into the INRMP during the annual review or at the five-year review period.

4.5 Comparison of Environmental Effects by Alternative

Issue/Resource Category	Significance Criteria/Indicators	No Action, Continue Current INRMP Alternative A	Revised INRMP with Targeted Resource Protection Alternative B (Preferred)	Revised INRMP with Maximum Resource Protection Alternative C
Indiana Bat Foraging Habitat	Acres of suitable forest and habitat types and the presence and quality of wetlands and riparian areas (closed, high canopy).	Forest habitat would be essentially unchanged and would remain in its current state. There would not likely be any degradation of riparian areas. However, there would be no improvement in the forest interior canopy structure or habitat along brooks or wetlands. Natural processes such as increased understory could degrade habitat. Additional information would be obtained with regard to bat habitat requirements.	Primary habitat would receive increased protection. The buffer zones along stream banks and around wetlands would enhance potential foraging areas. Acres of potential foraging habitat would be maintained.	Suitable habitat in upland area would be altered and improved. Riparian and wetland areas would be treated the same as Alternative B. Removal or thinning of the understory and the resulting release of larger trees overtime would improve the canopy and increase potential foraging acreage.
Indiana Bat Roosting Habitat	Number and location of potential roost trees.	More snags would be retained, but there would be no effort to identify actual roost sites. Although a remote possibility, it might be necessary to retain and preserve old abandoned buildings. If a roost site was discovered, steps would be taken to protect it. Additionally, an increased number of snags could support other cavity-nesting species.	Timber activities would be restricted to silviculture treatments designed to enhance habitats, or rehabilitate the impacts from catastrophic events. Surveys would be conducted to identify actual roosting sites. Given the emphasis on preserving snags, the potential roost sites would increase. The added protection of potential and/or existing sites would tend to stabilize the foraging and roosting bat population. Thinnings of stands could improve foraging and roosting habitat.	More accurate information on the number of roosting bats would be obtained and actual sites would be documented. Potential roost sites would continue to increase. The bat population using the area for forage and roosting would likely increase. Human (hunter) access to specified areas would be limited if sites were determined to be present. Both pedestrian and vehicular traffic could be curtailed depending on the location.

Issue/Resource	Significance Criteria	Alternative A	Alternative B	Alternative C
Bog Turtle Habitat	Acres of potential habitat and the estimated number of turtles that occur, if any.	This alternative would likely have a negative impact on habitat. Although activities would be avoided that increased successional growth, bog turtle habitat would likely be degraded over time as natural succession ensues. As grass or shrubland becomes dominated by early-seral trees, turtles could be forced to migrate to other areas if such suitable habitat exists or is within range.	Beaver dams would likely be breached and individual beavers or clans would likely be displaced. Woody vegetation would be deadened by appropriate means that would result in a net increase in herbaceous vegetation. Natural succession would thereby be reversed and the shrubland would be moved to more of a meadow environment. Removal of beaver dams and the killing of trees and shrubs as necessary would tend to stabilize the hydrology of the wetland. This in turn would maintain the turtle population to the extent that turtles occur.	Slight improvement in water quality could result if pollutants are intercepted. Actively promoting wetland connectivity and maintaining water quality would enhance bog turtle habitat. This would tend to sustain or increase the population depending on other natural factors. The turtle population would be surveyed and documented.
State-Listed Wildlife Habitat	Populations of wildlife that occur on the Arsenal	Current population trends (increase, decrease, or stable) will likely continue. However, the trends are unknown on Picatinny Arsenal habitat. Field documentation would provide information for selected species such as the wood turtle, timber rattlesnake, bobcat, and pied billed grebe.	There would be no incremental effects in the field or on the ground. Surveys and documentation would provide baseline data. Potentially positive effects would result from conducting surveys prior to ground-disturbing activities. Also, the plotting of species would avoid unnecessary damage to associated habitats. The protection of species once identified would increase species viability.	Same as Alternative B.

Issue/Resource	Significance Criteria	Alternative A	Alternative B	Alternative C
Brook-Trout Habitat	Estimated number of trout produced and the number caught by sports fishermen in a designated stream segment (middle or upper Green Pond Brook).	Expansion of the brook trout population into the middle portion of Green Pond Brook would not likely occur. Also, breeding and spawning habitats are not likely to expand downstream. The population size and location would tend to remain static or may actually decline. Increased danger of extirpation would be possible.	Expansion and recruitment of brook trout into the middle portion of Green Pond brook would likely occur. This would increase species diversity in the middle portion of the brook and would tend to stabilize the trout population in the upper portion of Green Pond Brook. The threat of extirpation would be reduced.	This alternative would likely increase the trout population in both portions of the brook. It would result in the temporary suspension of fishing in the brook. That in turn could have an indirect effect of decreasing diversity since the middle portion of the brook would not be stocked and only native species would be favored.
Hydrology and water quality.	Compliance with the <i>Clean Water Act</i> and applicable federal and state laws.	No degradation of hydrology or water quality is anticipated. Protection of riparian areas and establishment of buffer zones would likely improve water quality by reducing sedimentation, reducing water temperature, and possibly reducing contamination from non-point sources. The Arsenal would continue to be an important link in Watershed Number 6 and the Highlands Region. Management actions would be neutral or beneficial to water quality.	Same as Alternative A.	Same as Alternative A.

Issue/Resource	Significance Criteria	Alternative A	Alternative B	Alternative C
Wetlands and aquatic habitats.	Loss or substantial degradation of wetland areas, water quality, or native plants and vegetation that provide buffers or are associated with essential habitats.	No degradation of wetlands or aquatic habitats is anticipated. Protection of riparian areas and establishment of buffer zones would maintain or improve wetlands and associated habitats. Control of non-native plant species and habitat manipulation to protect the bog turtle and brook trout would also result in stabilized or improved conditions. Management actions would be neutral or beneficial to water quality.	Same as Alternative A.	Same as Alternative A.
Forested Woodlands	Species decline due to habitat loss from insects and disease outbreaks or other natural events such as wind and fire.	There would be no change in the types of species present. However, the forest would move toward a mature or old-growth condition. Shade tolerant species in the understory would likely increase.	There are no anticipated effects on the types of forest species although the seral stages could change in selected areas. Portions of the forest may become less monotone and more of mixed species and age across the landscape over time. Management actions could increase dispersal habitat or create forest openings in selected areas. Impacts to biodiversity and forest connectivity are discussed under Wildlife.	Same as Alternative B
Forest Insects and Disease	Increase in insect populations and disease outside the range of natural variability as established by historical records, research, and future monitoring.	Anticipated management actions in any of the alternatives would not likely substantially affect the incidence of disease in hemlock. However, thinning of the understory to produce higher canopy and larger trees (improve bat foraging habitat) would tend	Same as Alternative A	Same as Alternative A

Issue/Resource	Significance Criteria	to improve tree vigor. Alternative A	Alternative B	Alternative C
Wildlife; Game and Non-Game Species	<p>a) Acres and pattern of mature forest or dispersal habitat contiguous to public areas outside the Arsenal.</p> <p>b) Number of acres forming blocks of forested habitat, their location on the landscape, and populations and types of species.</p>	<p>The forest and woodlands would continue to move successionally toward old growth or climax conditions. The ecotone situation that would likely result may not match with the surrounding land areas. This could create a mismatch between various types of habitat and the current wildlife species. It would also have the potential to disrupt migration corridors. As a result, Picatinny Arsenal could become an isolated eco island. The effect on biodiversity of species is unknown, but would be largely influenced by happenstance. To the extent that populations would become isolated within the Arsenal, the potential for extirpation of species would increase. There would be no effect on game species.</p>	<p>Species diversity would be maintained if not enhanced. Connectivity would also be maintained or enhanced. Unfragmented interior forest would continue to support neotropical migrants and/or the 208 species of birds known to occur on the Arsenal. Forest fragmentation would be minimized. There would be management consistency with land management areas outside the Arsenal boundary that would further enhance habitat connectivity throughout the larger region. Human animal interaction would also be less likely to occur (i.e. road kills and nuisance situations).</p>	<p>There would be a net increase in good quality habitat throughout the Arsenal, especially along riparian areas (to include developed portions of the installation). Connectivity and species diversity would be enhanced as natural forest cover and landscape patterns were restored. There would be anticipated changes in the patterns of home ranges and habitat utilization by some species. Restrictions on roads and fences would reduce fragmentation and thereby improve the quality of forest interior habitat. This would further enhance biodiversity. This alternative could impact mission capability by restricting expansion of facilities, especially those not located in the current developed cantonment area.</p>

Issue/Resource	Significance Criteria	Alternative A	Alternative B	Alternative C
Non-Native Plant Species	<p>a) Location of invasives relative to T&E plant species and the impacts thereon.</p> <p>b) Populations, types, location, and concentration of non-native plants.</p> <p>c) Compliance with Presidential Executive Order 13112, dated February 1999.</p>	<p>Natural changes would continue to occur resulting in incremental encroachment of invasive species over time. Although the precise effects are unknown, there would be a likely decrease in species diversity as invasive plants eliminated native species. This would be especially dramatic if such species as common reed became evident in wetland areas. Species such as the bog turtle and those that utilize meadows and grassy areas could be highly impacted. Elimination of native grasses and meadows would especially impact grassland species of birds. Human activity would increase the opportunities for non-native species to be transferred to new areas.</p>	<p>Control and/or eradication of non-native species on the Arsenal would actually increase or maintain species diversity. The general condition would likely improve. Current wetland and meadow habitats would be maintained. Endangered species habitat (both animal and plant) would be protected. An indirect effect of surveys would be inadvertent destruction of native Endangered Species or Species of Concern.</p>	<p>The more precise and aggressive management of known sites and the additional information gained from surveys would result in an increase in native vegetation and a reduction in non-native species. This would represent an added improvement over other alternatives. However, it substantially increases costs.</p>
State-Listed Plants	<p>Populations of plants that occur on the Arsenal.</p>	<p>Natural process would continue. The direct effects from human activity and development would be the additional loss of species and populations. An indirect effect of the documentation would be additional passive protection for those plants or sites identified.</p>	<p>The general condition would improve especially for those species considered to be Endangered. Site surveys would prevent the inadvertent destruction of plants. Since the majority of the plants are aquatics, preservation of water quality would enhance state-listed populations.</p>	<p>Better information and data would provide added protection and avoiding detrimental activities would increase the populations of state-listed plants.</p>

Issue/Resource	Significance Criteria	Alternative A	Alternative B	Alternative C
Outdoor Recreation	Number of people allowed in specified areas for specific activities. Number and types of game species available for hunting and the number actually taken.	There would be no substantial change from the current condition. However, positive effects would accrue from the educational awareness activities and minimizing disturbance to select plant and animal species. For some species such as deer, hunting would be an effective management tool for controlling the population. The protection of riparian areas and potential roost trees would prevent negative effects on Indiana bats. Bog turtle habitat characteristics are such that they provide a natural barrier to human intrusion. Current restrictions and controls would keep impacts to a minimum. Further reductions or restrictions of activity would be based on safety concerns. The possible exception could be fishing if it would become necessary to suspend activity or the put-and-take program.	Same as Alternative A.	Same as Alternative A.

Issue/Resource	Significance Criteria	Alternative A	Alternative B	Alternative C
Land Use	Compliance with Master Plan and Presidential Executive Orders on Environmental Justice and Protection of Children from Environmental health and Safety Risks.	None of the alternatives would impact current land use. However, Alternative C would likely restrict future development of expansion beyond those areas currently developed. Expansion of current uses or facilities outside the presently developed areas is not anticipated. None of the alternatives would increase or decrease the workforce. There would be no effects on current facilities.	Same as Alternative A. In addition, there would be no disproportionate effects on minority or low-income populations. This alternative would not change or further restrict access to the installation or its resources. Furthermore, children would not be disproportionately affected because none of the proposed management actions, treatments, or standards and guidelines would negatively impact children.	Same as Alternative B
Cultural Resources	Any actions that adversely impact cultural resources and that cannot be mitigated.	No Impact	No Impact	No Impact
Forest Products	Excessive wood fiber production from environmentally sensitive areas.	Due to both limited acreage of commercial forest land, as well as multiple use management values and objectives, timber harvests will continue to be occasional and infrequent. Timber sales or harvest would likely occur only for the purpose of improving habitat conditions or improving safety. The best opportunity for timber harvest and sales in the immediate future may be for fuel wood, subject to limitations and standards and guidelines. However, the installation's forest will not likely be managed in the future as an industrial forest for maximum timber production.	Same as Alternative A	Same as Alternative A

5.0 ENVIRONMENTAL JUSTICE

Executive Order 12898 was issued on 11 February 1994. The order requires certain federal agencies, including DoD, to the extent practical and permitted by law, to make environmental justice part of their missions by identifying and addressing disproportionately high and adverse health or environmental effects on minority and low-income populations.

Implementation of a revised INRMP at Picatinny Arsenal would not cause disproportionately high or adverse health effects that impact minority or low-income populations. The INRMP is intended to benefit natural resources and the overall ecosystem. Deleterious effects that impact either the natural or human environment are not anticipated. Implementation of the Preferred Alternative would not change or further restrict access to the installation or its resources. Future restrictions, if any, will likely be required for safety reasons.

6.0 PROTECTION OF CHILDREN FROM ENVIRONMENTAL HEALTH AND SAFETY RISKS

Executive Order 13045 was issued on 21 April 1997. The order makes it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children. It also directs agencies to ensure that policies, programs, activities, and standards address such risks if identified.

Implementation of the INRMP at Picatinny Arsenal would not disproportionately affect children because none of the proposed management actions, treatments, or standards and guidelines would negatively impact children. Also, children are not normally present in the areas to be treated and given the intent of the INRMP, any treatments proposed or used would protect air and water quality. When using chemicals (fertilizer, herbicides, insecticides) to treat developed areas, the site-specific assessment will consider impacts to children and adults as well as wildlife and water quality. Furthermore, there are no anticipated impacts to children off the installation from military or management activities.

7.0 CONCLUSION

Implementation of the Preferred Alternative results in the most effective method to comply with the *Sikes Act Improvement Act*, Army Regulation 200-3, and DoD Instruction 4715.3. It also best enables Picatinny Arsenal to meet mission requirements while enhancing the environment through integrated natural resource management. Therefore, the proposed action does not appear to constitute a major federal action significantly affecting the quality of the human environment. The anticipated direct and cumulative effects would be positive and the Preferred Alternative would provide additional environmental safeguards, especially for Threatened and Endangered species. There are no indications that implementing the Preferred Alternative would violate any federal, state, or local environmental laws or regulations. Given the projected environmental benefits, an Environmental Impact Statement is not required.

GLOSSARY

This glossary contains a list of acronyms, abbreviations, and technical terms used in this Environmental Assessment. Words that would be defined in a desk-size dictionary (for example, the College Edition of the American Heritage Dictionary) are not necessarily included.

Acronyms and Abbreviations

CWD	Coarse woody debris
dbh	diameter breast height (point 4.5 ft above ground)
DOD	Department of Defense
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
E&T	Endangered and Threatened (plants)
GIS	Geographical Information System
NEPA	National Environmental Policy Act of 1969
NJDEP	New Jersey Department of Environmental Protection
S&G	Standard and Guideline
T&E	Threatened and Endangered
USFWS	United States Fish and Wildlife Services

Technical Terms

Biodiversity. Short for biological diversity: The variety, distribution, and structure of plant and animal communities.

Blowdown. Trees felled by high winds.

Bog. A wetland area generally formed in a depression with a combination of cool climate and abundant moisture. Bogs receive little or no discharge of water from groundwater aquifers and are dependent on precipitation for moisture. Typically characterized by high moss productivity and accumulation of peat.

Buffer area. An area adjacent to suitable habitat that reduces the dangers of sharply contrasting edges caused by clearcutting or other activities.

Buffer zone. An administratively defined area established along a stream, lake, wetland, or erosion hazard to provide protection for aquatic resources during land-use activities.

Coarse woody debris (CWD). Dead and down wood material 6 inches in diameter and greater.

Connectivity. A measure of the extent to which conditions among forest, grassland, and riparian areas provide habitat for breeding, feeding, dispersal, and movement of associated wildlife and fish species.

Critical habitat. For threatened or endangered species, the specific areas within the geographical area occupied by the species on which are found those physical or biological features essential to the conservation of the species.

Dispersed recreation. Outdoor recreation that takes place outside developed recreation sites or off-road areas.

Drainage. An area or basin drained by a river and its tributaries.

Early-seral stage. Stage in forest development that includes seedling, sapling, and pole-sized trees.

Ecosystem. Ecosystems are collections of living organisms and their physical environment (soil, air, water). This collection includes the transfer of nutrients and energy through the system.

Ecotone. An ecological community of mixed vegetation formed by the overlapping of adjoining communities.

Edge effect. The drastically modified environmental conditions along the margins or "edges" of forest patches surrounded partially or entirely by harvested lands or other such open areas.

Extirpate. To totally destroy, exterminate, or eliminate a species from an area.

Fen. A wetland area generally formed in a depression that receives water from the surrounding watershed through in-flowing streams and groundwater. Distinct from a bog that receives water from precipitation. Fens reflect the chemistry of the geologic formations through which the water flows.

Forest commodity or product. Resources extracted from the forest such as timber, Christmas trees, native ornamental trees and shrubs, cut or picked evergreen foliage, cedar products, berries, mushrooms, and transplants.

Free flowing. A brook or stream having a flow of water that is not artificially regulated or influenced by dams or diversions.

Fuel reduction. The rearrangement or disposal of natural fuels to reduce the potential of fire.

Fuel wood. Amount of dead and down material that may be used for burning and firewood.

Hibernaculum. A case, covering, or structure in which an organism remains dormant for the winter.

Historical variability. The pattern or range of natural events in a particular area over time.

Hydrology. The science dealing with water on land: its properties, laws, and geographical distribution. The hydrology of an area determines the way in which a wetland functions and is supplied with water. For example the source of water in a wetland could be from surface runoff, underground, or a combination of both.

Landscape. An extensive area pertaining to inland or coastal regions.

Late-successional. A forest in its mature and/or old-growth stages. Also called late-seral stage forest. Typical characteristics are moderate to high canopy closure, a multilayered and multispecies canopy dominated by large overstory trees, numerous large snags, and abundant coarse woody debris (such as fallen trees) on the ground. Typically, stands 80 to 120 years old are entering this stage.

Lentic. Still water typically found in lakes or ponds.

Lotic. Moving water usually associated with rivers, streams, and brooks.

Mature forest. A stand of trees typically five acres or greater for which the annual growth has peaked. Stands are generally greater than 80 to 100 years old and less than 180 to 200 years old. Stand age, diameter of dominant trees, and stand structure at maturity vary by forest cover types and local site conditions. Mature

stands generally contain trees with a smaller average diameter, less age class variation, and less structural complexity than old-growth stands of the same forest type.

National Environmental Policy Act (NEPA). An act, passed by Congress in 1969, that declared a national policy to encourage productive harmony between humans and their environment to promote efforts that will prevent or eliminate damage to the environment and the biosphere. The act requires the preparation of environmental impact statements for Federal actions that are determined to be of major significance.

Neotropical. The geographic region stretching southward from the Tropic of Cancer, including southern Mexico, Central and South America, and the West Indies.

Non-point-source pollution. Pollution coming from a general source, such as land runoff, rather than a specific location such as a pipe.

Old-growth. An old-growth stand is defined as a stand of trees 10 acres or greater generally containing old trees, multilayered canopy, standing dead trees and downed material. This stage exists from approximately age 250.

Open roads. Roads that are available for street-legal vehicle use during any part of the year. This includes use for administrative or management purposes.

Overstory. That portion of the trees in a forest of more than one story, forming the upper or uppermost canopy layer of the forest.

Palustrine. Forested wetlands, often called swamps or wooded wetlands, where trees are the dominant plants.

Preferred Alternative. The alternative which the agency believes would fulfill its statutory missions and responsibilities giving consideration to economic, environmental, technical, and other factors.

Prescribed fire. A contained fire in a wild setting burning under pre-planned specified conditions that will accomplish certain planned objectives. The fire usually results from planned ignitions.

Proposed Action. The way the agency proposes to meet the objectives and respond to the stated need for action.

Riparian area. The area including the stream channel, lake or estuary bed, water itself, and the plants that grow in the water and on the land next to the water.

Road. A planned and approved segment of the transportation system.

Road closure. Preventing use of a road through the use of gates, signs, barricades, area closures, or other devices. Unlike road decommissioning or obliteration, it does not affect the prism of the road. Closures may pertain to motorized and/or nonmotorized use.

Road decommissioning. The removal of a road from the road inventory. The road may remain in place, but it is no longer maintained. Typically the road is closed or obliterated since it is not anticipated as being necessary for future forest management activities.

Road obliteration. Putting the road back to the original contour of the land. Road obliteration does not necessarily mean removing the entire road. It may only affect critical sections.

Scoping process. A part of the National Environmental Policy Act process used to determine the scope and significance of issues and the range of alternatives needed using public input.

Selected Alternative. The alternative selected by the deciding official for implementation.

Seral community. A community existing prior to the climax or "final" vegetation community is referred to as seral or successional.

Series. Trees grouped together according to climate and species dominance.

Sikes Act. An act to promote effective planning, development, maintenance, and coordination of wildlife, fish, and game conservation and rehabilitation on military reservations. Amended in 1997 as the *Sikes Act Improvement Act*.

Silviculture. The art and science of controlling the establishment, composition, and growth of forests.

Snags. Standing dead trees with similar characteristics, such as age, size, and species. at least six inches in diameter at breast height and at least six feet tall.

Stand. Groups of trees in a small geographic area.

Terrestrial. Growing on land or on the ground, not aquatic.

Turbidity. The degree to which water or other liquid, opaque or muddy with particles of extraneous matter.

Understory. Vegetation growing under a higher canopy.

Unroaded area. Those areas of federal land within which there are no improved roads maintained for travel by means of vehicles intended for highway use.

Urban interface. Any place where flammable vegetation meets human structures.

Watershed. The entire region or land area drained by a river or stream typically defined or divided from other drainages by a ridge or crest.

Wetland. Transitional land between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered with shallow and sometimes temporary or intermittent water. Usually characterized by a prevalence of vegetation adapted to saturated soil conditions. Generally include swamps, marshes, bogs, fens, seeps, and wet meadows. Deep rivers, lakes, and streams are not included.

Wildfire. An uncontrolled wildland fire, human or natural caused..

Woody debris. See "coarse woody debris."

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APPENDIX A

REGIONAL CONTEXT

I. New Jersey Highlands

A. PHYSICAL ENVIRONMENT

1. Setting

The New Jersey Highlands is a region of 1.1 million acres stretching from the Hudson River to the Delaware River. It encompasses all or parts of nine counties and ninety-two municipalities (see map on page 65). It is a landscape of national significance that is rich in natural resources and recreation opportunities. The importance of the region is based on its location and characteristics:

148,000 acres of public open space,

Clean drinking water for over 3.8 million New York and New Jersey residents,

More than 500,000 acres of critical wildlife habitat that is mostly in forest land and is primarily privately owned (75%),

An integral part of the Maine-Georgia Appalachian chain providing habitat connectivity for numerous species of wildlife.

The highlands area is virtually in the back yard of the Nation's largest metropolitan area, home to approximately 20 million people. About one in 12 Americans live within a one- to two-hour drive of the highlands. Consequently, the Highlands are potentially critically important for the protection of the drinking water supply and the conservation of the natural landscape for wildlife habitat. Retention of a working landscape is also important for providing farm and forest products, open space for outdoor recreation, and buffers between urbanized areas.

Within 40 miles of Manhattan, the Highlands ecosystem is home to black bear, otter, bobcat, and native trout. More than 500,000 acres of important habitat provides a critical flyway and nesting ground to nearly 100 species of neotropical songbirds (THC). However, the highlands face the immediate prospect of unprecedented urbanization given trends in the area. The tri-state area of New York, New Jersey, and Connecticut has had a 60 percent increase in the amount of urban land in the last 25 years with only a six percent increase in population. Nationally, massive commercial and industrial development has jumped from the central city areas to the suburbs. The outlying areas of the American metropolitan regions are receiving most of the new regional job growth.

As a result of the development patterns, housing and subdivisions have edged further into the rural areas thereby replacing farms, wildlife habitat, and close-to-home recreational opportunities. Scattering people and jobs over the landscape creates a physical arrangement that causes traffic congestion, worsens air quality, reduces the attractiveness of the landscape, and threatens the quality and supply of drinking water. This in turn may threaten the long-term economic viability of the area if businesses choose to locate and invest in areas with better ecological health.

Given the significance of the region's water supply and wildlife habitat, protection of the Highlands is critical to the long-term health of the region. Accommodating new residents could result in the Highlands becoming a part of the suburban landscape that extends north and westward from New York City. In the next 10 to 15 years many of the counties in the area, to include Morris County, will be considered urban. The effects of suburbanization and urbanization in the area are already apparent.

It is estimated that by 2010 another 15,000 acres of farmland and more than 17,000 acres of forested land in the Highlands will be lost to residential or urban uses.

Continued development will increasingly place the natural resources of the Highlands at risk. One immediate consequence is that the forest is increasingly fragmented into smaller and smaller tracts. As additional development occurs, large forest patches will decline significantly. This fragmentation will eventually alter the physical and biological resources of the region. If the trend continues, it may result in lower quality drinking water, reduced aquatic habitats, the loss of large contiguous forested areas with the associated loss of wildlife and fish, degraded recreational experiences and scenic quality, the destruction of cultural resources, and the loss of a viable forest products industry.

2. Air Quality

National Ambient Air Quality Standards (NAAQS) have been established for six pollutants that are monitored in and around the Highlands on a routine basis. Pollutants that affect air quality (visibility, acid deposition, meteorology, etc.) are also routinely monitored. Annual average of rainfall shows that acid precipitation is a present environmental problem in the region.

Visibility is considered to be an important natural resource in the Highlands. Because much of this area is pristine, special regulations protecting visibility in national parks and wildlife refuges have been promulgated. Although no definitive trend in visibility has been discovered, it appears that a strong seasonal variation exists with the poorest visibility occurring during the summer.

3. Geophysical and Soil Characteristics

The mountains and valleys that comprise the Highlands are part of the Reading Prong. The province rises above the lower lying Triassic lowlands along their southeastern border. Millions of years ago these mountains uplifted along faults. The Ramapo Fault separates the Highlands province from the Triassic Lowlands. A series of discontinuous, steep-sided ridges and arrow valleys typify the landscapes of the region. Millions of years of erosion have exposed across much of the region a Precambrian bedrock complex of rock. Sedimentary rock is also found within the region. Green Pond and Schunemunk conglomerates are common in the northern areas. In the southern and western most areas, Kittatinny Limestone is present.

A combination of geologic forces, including a period of glacial advances, resulted in the existing rough terrain. The glacial movements striped the higher elevations and redeposited the soil materials in the lower slopes and valley bottoms. The depth of the glacial material ranges from one to two feet on the lower slopes to many feet in the valley bottoms. Soils that formed on the slopes and upper portion of the ridges are shallow and very stony which severely limits them for most activities other watershed protection. Soils on the lower slopes and valley bottoms are variable depending on their location. Some are stony and have an impervious layer that restricts percolation while others are deep and well-drained. An occasional high seasonal water table in these areas limits their use for development.

The mineral makeup of the rocks has shaped much of the history of the Highlands. Iron in numerous mineral forms is present throughout the region. Veins of iron deposits were extensively mined in the past and iron played an important role in the historical development of the area, especially during early wars for independence. Also of note are the subterranean solution cavities and caves resulting from the dissolution of limestone and dolomite by groundwater. Carbonate rocks are present where sinkholes exist and carbonate rock is characterized by very high yields of good quality groundwater.

Another significant mineral resource is uranium. Uranium has been mined in the Highlands in the past. Mining and the milling of uranium could release hazardous decomposition products such as radon gas. Radon gas has been found to accumulate in basements on homes in the Highlands.

4. Water Resources

Approximately 40 to 50 inches of rain falls annually in the Highlands. This rainfall provides important ground and surface water resources. Due to the predominant forest cover, the quality of water is very high ("good" to "excellent") in the ten principal waterways in the Highlands. The forest cover in the region is also responsible for reducing peak flow that causes flooding and for maintaining minimum flows. It also maintains the quality and quantity of water recharge to groundwater aquifers and surface waters of the Highlands. Equally important is the dependence of the forest vegetation on the water balances and soil moisture content within the hydrologic system.

The critical water resources of the area are used for drinking water. There are ten major reservoirs and more than a dozen smaller impoundments located in the Highlands. These and other public water resources in the Highlands supply drinking water for nearly 3.8 million people in New York and New Jersey. Four of the six major surface supply systems for the northern part of New Jersey are located in the Highlands (THC). In addition, seven major rivers are considered cold and clean enough to permit trout production and maintenance. Water may be the region's most valuable resource.

5. Timber

The current harvest level is estimated to be about ten percent of the annual growth rate. A high percentage of the timberland can be classified as having too many trees per acre causing overcrowding and loss of vigor and health. The economic value of the sawlog and veneer harvest is over 3.2 million (1991). Another \$8 million of cordwood is harvested. Forty-eight percent of the Highlands region is forested, but most of the Highlands timberland is broken into small, privately owned tracts. Many of the private owners value the timberland for aesthetics and enjoyment rather than its economic value. Large contiguous tracts of timberland that could be efficiently and economically managed are rare.

6. Agriculture

There are approximately 160,000 acres of land classified as agriculture within the Highlands. Most farms in the region are in the 10 to 49 acre size class. They:

- Contain many of the region's vast forest resources,

- Contribute significantly to the area's economy (over 120 million dollars per year),

- Sustain the intrinsic natural character of the working landscape,

- Provide jobs and a sustained quality of life for many landowners and residents of the Highlands.

Farm production in the region is quite varied. It includes livestock and poultry such as cattle, beef cows, milk cows, hogs, sheep, and chickens. It also includes crops such as corn, soybeans, hay, vegetables, orchards, fruits and nuts, berries, greenhouse crops, mushrooms, and sod. However, since about 1970, the percentage of agricultural land has decreased as a result of continued development and other economic factors.

B. BIOLOGICAL ENVIRONMENT

1. Biological Communities

Biological diversity means the variety of life and its processes. It refers to genetic variation, distinct species, biological systems, and the variety of systems and their linkages across regional landscapes.

Two primary systems, terrestrial and freshwater wetlands are represented in the Highlands, predominantly in the large, contiguous blocks of forest. Within each system, there are a number of communities that constitute local variability. It is this variability that provides the Highlands with rich diversity of community types: glacial bogs, hardwood-conifer swamps, rock outcrop communities, and chestnut oak forests.

Maintaining biological diversity results in both physical and social benefits. Physical benefits accrue to the region from the natural vegetation systems. Physical benefits include: habitat for wildlife, protection against floods, replenishment of groundwater supplies, preventing land and soil erosion, climate control, and cleaner air. Social benefits include recreation opportunities for hunting, fishing, hiking, and wildlife observation; and the creation or maintenance of open space that offsets urbanization and increases land values and the quality of life.

2. Fish and Wildlife

The land and water of the Highlands support significant populations of fish and wildlife. Over 140 species of birds are known to nest in the Highlands. This includes over 40 species of nesting birds, migrating raptors, and waterfowl. Of particular concern are the 70 plus species of interior nesting neotropical migrants such as the red-eyed vireo, American redstart, Canada warbler and eastern wood-pewee, all of which require undisturbed forest patches.

A significant resource is the extensive areas of uninterrupted, unbroken forest. Large blocks of habitat, connected by corridors to other large blocks, are essential for preserving and enhancing biodiversity. Such habitat also provides migration corridors for large mammals such as bobcat, black bear, and river otter; and extends the feeding and breeding range of these populations. There are also extensive cold water wild trout fisheries throughout the region. Other species present are yellow perch, small mouth bass, and anadromous fisheries in the Delaware and Hudson Rivers.

3. Endangered and Threatened Species

The Highlands region supports hundreds of species of flora and vertebrate fauna that are listed on state inventories for endangered or threatened species. Endangered or threatened (T&E) species within the Highlands region include: the timber rattlesnake, wood turtle, red-shouldered hawk, barred owl, osprey, great blue heron, and eastern wood rat. Also, on state lists within the Highlands are hundreds of plant species listed as endangered or threatened. Of these, at least ten have some type of federal status.

Suitable habitats are critical for T&E species. The Highlands Region provides a vital link for many species of long distance migratory birds that travel to and from South or Central America (neotropical). Each year neotropical bird species pass through and breed in the area. Examples include warblers, thrushes, cuckoos, tanagers, orioles, grosbeaks, vireos, and flycatchers. Neotropicals represent a quarter of all US birds in the Highlands and half the breeding species. As in the East in general, many of these birds are thought to be in serious decline in the Highlands.

C. OTHER IMPORTANT RESOURCES

1. Land Use

The New Jersey Highlands are 45 percent forested (334,500 acres), 18 percent agricultural (136,700 acres), and 37 percent urbanized (271,500 acres) including residential development (THC). The northern part is more heavily forested while the southern portion is more agricultural. Morris County has the largest forested area with nearly 96,000 acres. However, Morris County also has 58 percent of

its Highlands area in urban uses (150,000 acres) (THC). Surrounding counties are somewhat less urbanized.

About ten percent of Highlands open space (48,000 acres) is watershed land managed by water supply authorities. The largest single ownership in the region is the City of Newark.

2. Recreation

The Highlands provide outdoor recreation opportunities for over 8 million people a year. There are over 147,000 acres of county, state, and federal parks in the Highlands and there are over 48,000 acres of land and water owned and managed by water purveyors. Although a percentage of these latter areas are not physically accessible, they provide scenic and wildlife values. Additionally, there are 548 miles of linear recreational features such as regional hiking trails, including the Appalachian Trail, abandoned canals, and county greenways, and there are approximately 750 miles of local hiking trails of which about 25 percent are on private land.

The heavy use does not meet current demand. It's estimated that an additional 75,000 acres of public parkland are needed to meet current demand. However, about 84 percent of the Highlands' open space is privately owned and is in danger of being developed. Recreational opportunities are economic as well as quality-of-life issues. The recreation and tourism industry in the nine-county Highlands area directly employs some 72,000 people with a payroll estimated at nearly \$900 million.

3. Cultural Resources

Human settlement in the Highlands has resulted in a rich array of archeological sites, agricultural uses, and industrial remnants, many of which have remained intact in their original setting. Based on surveys of prehistoric periods, prehistoric peoples used the shelters formed by rock outcroppings throughout the Highlands. Artifacts include projectile points, knives, tools, beads and pottery. Native American groups in the area included Minisinks, Hachensacks, and Tappans, all of whom were part of the widespread Algonquin linguistic and cultural ancestry.

The Highlands has been an area where diverse cultures have come into contact. The first Dutch settlers came south from the Hudson Valley. The distinctive Dutch stone houses exist today. Quickly overlaid on the Dutch culture was a mixture of English and Scots-Irish.

Highland water has been crucial for exploration and development of the area. The rivers provided transportation and supply routes in and out of the area prior to roads. The streams exposed the iron deposits that lay beneath them and then provided the power for mining operations and other industries. Highlands' iron, along with the abundant timber that provided charcoal for its processing, defined the region's development (Regional Study). Highlands' iron won the Revolutionary War. Bullets, cannon balls, and all kinds of armaments were made in Highlands' forges. In the process, a sound economy was created in the area that persisted until the Civil War. However, by then the railroad had made sources accessible farther west in Pennsylvania and the New Jersey iron industry slowly declined. Today, there is no accurate count of the historic industrial sites in the Highlands.

II. Watershed Management Area 6

A. PHYSICAL ENVIRONMENT

1. Setting

Watershed Management Area 6 (WMA#6) is one of 20 watershed management areas in New Jersey. A watershed encompasses all the land that drains to a particular water body and has a natural boundary. Included in WMA #6 are the Rockaway, Whippany, Mid Passaic, and Upper Passaic Watersheds. WMA #6 is approximately 416 square miles and is about 30 miles long and 20 miles wide at the widest points. It is located in northeastern New Jersey, primarily in Morris County, although it includes small portions of Sussex, Somerset, Essex, and Union Counties (see map on page 73). It lies within the mountainous Highlands Region where elevations range from 300 to 1400 feet. The Picatinny Arsenal is located in the northern portion of WMA #6 in the Rockaway Watershed. Refer to map in Appendix F of the Integrated Natural Resources

The geology consists mainly of fractured bedrock. Unlike the northern area, the southeastern portion lies in the lower hills and swamps of the Piedmont Province where the geology consists primarily of sedimentary rock and glacial deposits. This geology influences the availability and movement of ground water and the course and hydrology of its rivers. The Whippany River drains the central portion of the Management Area and is about 15 miles long. It joins the Rockaway River that runs for approximately 40 miles and drains the northern portion of WMA #6. The Rockaway eventually joins the Upper Passaic River that is 50-miles long and drains the southeastern portion of the Management Area. This latter river runs through the Great Swamp National Park in the south before leaving WMA #6.

2. Land and Open Space

As of 1986, land uses in WMA #6 include urban/developed (189 square miles, 45%), forested (166 square miles, 39%), wetlands (35.5 square miles, 8.4%), water (11.4 square miles, 2.7%), agriculture (11 square miles, 2.6%), and barren land (3.2 square miles, 0.8%). As of 1990, approximately 600,000 people resided in 52 municipalities that lie entirely or partially with the management area. The population is expected to grow to nearly 650,000 by 2020. That will in turn increase the density per square mile.

As indicated above, in 1986, almost half the land in WMA #6 was developed land. Historical industrial development has resulted in over 500 contaminated sites. Currently, 63,000 pounds per year of active pesticide ingredients are applied to lawns, golf courses and farmlands in the management area. In addition, about 70 million gallons of treated wastewater are discharged daily. Industrial and housing developments will continue to pressure water supplies from increasing demands for water. As land is developed, habitat for native and rare, threatened and endangered species is accordingly reduced. However, at least 15 percent of the area has been preserved for open space and recreation and wetland regulations have dramatically slowed the pace of loss of this habitat.

Public open space is land owned and managed by government agencies and nonprofit conservation groups for natural resources protection, recreation, and agricultural preservation. State and federal public open space (including US Army property) totals approximately 23,000 acres, or about 10 percent of the total management area. Park systems, conservation easements, and protected open space increases the percentage to somewhat over 15 percent. The 15 percent of the area that has been preserved for open space equates to about 62 square miles. The actual amount may be higher since GIS mapping is incomplete. Municipalities, counties, state and federal agencies, and nonprofit

conservation groups are continually attempting to add to the both the amount of open space and its connectivity by acquiring undeveloped land.

3. Forest Resources

Data collected for the last USDA Forest Service Survey in Forest Statistics for New Jersey (1987) shows that about 41 percent or 122,500 acres are classified as "timberland." Timberland is defined as woodland that is capable of growing at least 20 cubic feet of wood per year and the land has no restrictions for timber utilization. The ownership of the timberland is as follows:

Private	88,200 acres	72.0%
County and municipal	27,800	23.0%
State	4,300	3.5%
Federal	2,200	1.8%

Most of the forest land (82,000 acres) is in tree stands in the older larger size classes of eleven inches in diameter or greater. There is no acreage in the seedling/sapling age class. Consequently, the forest is characterized by having very few early-successional forest stages across a landscape that is somewhat fragmented due to the loss of forest by conversion to other uses.

The forest in WMA #6 can be divided into four basic units or communities that characterize regional differences in land use and the landscape:

Glaciated Highlands: Occupies the northern quarter of the watershed. Large forested tracks exist in this portion of the watershed. Communities are dominated by a mixture of red, white, black, and chestnut oaks that comprise between 40 and 50 percent of the canopy. The subcanopy is dominated by a mixture of red maple, sugar maple, black birch, and American beech.

Unglaciated Highlands: Occupies the western 1/6th of the watershed. Large forested tracks are present in this portion of the watershed. Communities are dominated by a mixture of black, red, white, and chestnut oaks, comprising 45 percent of the canopy. Sweet birch, red maple, pignut hickory and beech are common in the subcanopy. Tulip trees are sometimes co-dominant with the oak. Sugar maple, birch, and hemlock are common in the ravines.

Glacial Lakes Plains: Occupies the central lowlands between the Highlands and the Watchung Range covering the SE portion of Morris County. Forested communities are fragmented by urban development and are mostly swampy. Some are seasonally flooded. All are dominated by red maple, sweetgum, swamp white oak, and pin oak.

Newark Piedmont: Occupies the southern and eastern portions of the watershed. Communities are small and fragmented by urban development. They are dominated by a mixture of oaks and tulip trees that make up about 60 to 80 percent of the canopy in mature forests. Black birch and beech are common in the subcanopy.

4. Forest Health

General forest resource concerns include fragmentation, changes in historic composition, invasive species, lack of riparian forest buffers, and diminished diversity. As tree composition changes, so does the forest's ability to assimilate pollutants, control runoff, and provide habitat and forage. This in turn can have a substantial impact on wildlife species. Invasive insect species include gypsy moth, hemlock woolly adelgid, and the long-horned beetle. Invasive plant species include Norway maple, multiflora rose, Dutch elm, wild mustard, and Japanese silt grass.

The woolly adelgid is of particular concern to the hemlock within WMA #6. There are approximately 26,000 acres of hemlock (*Tsuga canadensis*) in northern New Jersey. Of this, approximately 2000

acres or 7.5 percent are in Morris County. Since hemlock grows along streams, rivers, ponds, and lakes, the loss of hemlock could significantly impact habitat and water quality. For example, 22 breeding bird species have been associated with hemlock. Three of these species breed primarily within hemlock ravines. Extensive hemlock mortality, creating forest gaps, could provide invasion opportunities for avian nest predators such as blue jays and cowbirds.

Additional impacts of hemlock mortality could include significant changes in energy and nutrient inputs to streams with hemlock riparian buffers. Defoliation will likely result in higher water temperatures that in turn will likely cause increased in-stream nitrogen and phosphorous levels and possible algal blooms. High in-stream temperatures could also cause increased native brook trout mortality.

B. WATER RESOURCES

1. Surface Water Quality

Biological monitoring has been conducted at 71 stations in WMA #6. Monitored stations are classified by the degree of impairment exhibited. Monitoring for all stations in the management area have shown that 32 percent of monitored stream miles are not impaired, 55 percent are moderately impaired, and 13 percent are severely impaired. These results are consistent with statewide (New Jersey) data. Chemical and sanitary water quality at seven stations in the management area indicate that phosphorus, suspended solids, and fecal coliform often do not meet New Jersey Surface Water Quality Standards (SWQS). These results are consistent with statewide data collected at other stations.

Biological monitoring of the Rockaway Watershed indicates that the headwaters and portions of the mainstem are not impaired. However, impairment tends to occur downstream and at the outlets of lakes. Chemical and sanitary water quality results indicate that numerical SWQS criteria for phosphorus, fecal coliform, and possible metals, are generally not met. Nitrate concentrations appear to have been rising significantly in the downstream portions of the river.

Biological monitoring of the Whippany Watershed indicates that the headwaters are not impaired. Nevertheless, moderate and severe impairment does occur in the Whippany and Watnong Brooks near Morristown. Chemical water quality monitoring results indicate that numerical SWQS criteria for suspended sediments, phosphorus, dissolved oxygen, and possibly metals, are generally not met. Nitrate concentrations appear to be significantly rising near Morristown.

Biological monitoring of the Upper Passaic Watershed indicates that the headwaters are not impaired or moderately impaired, but severe impairment as seen documented in Loantaka and Black Brooks and the Passaic River below Chatham. Chemical and sanitary water quality monitoring results indicate that phosphorus, dissolved oxygen, suspended solids, fecal coliform, and possibly metals, exceed the numerical SWQS criteria. Nitrate concentrations appear to be rising significantly downstream.

Lake Ames, Mount Hope Pond, and Sunrise Lake are considered to be eutrophic based on monitoring results. Eutrophication is accelerated due to inputs of nutrients and sediments from upstream point sources and nonpoint sources such as runoff and large waterfowl populations. Streams and lakes that do not meet surface water quality standards, exhibit moderate or severe impairment based on benthic data, or have fish consumption advisories are listed in the Water Quality Limited Waters Report (303d list).

2. Ground Water Quality

The result of the Ambient Ground Water Quality Monitoring Program indicate that the natural quality of ground water from locations throughout WMA #6 is good when compared to ground water and

drinking water quality standards. In some areas, however, gross alpha radiation, sodium, total dissolved solids, hardness, iron, manganese, aluminum, sulfate, and low and high pH may exceed secondary drinking water criteria but do not adversely affect water potability. Groundwater quality in some locations is affected by volatile organic chemicals and other pollutants. These pollutants are thought to arise from contaminated sites such as underground storage tanks, commercial septic systems, drum storage, and coal gasification facilities. Elevated concentrations of chloride from road salting and nitrogen compounds from fertilization may also affect the quality of the groundwater. However, the complex geology of WMA #6 makes accurate monitoring and assessment difficult.

3. Drinking Water Quality

Drinking water is supplied from six reservoirs and over 600 public supply wells. Results of the required regular testing indicate that finished drinking water quality usually meets the microbiological and chemical drinking water standards. In WMA #6 surface water supplies are currently meeting standards, but are threatened by eutrophication due to excess phosphorus. Drinking water supplies may be threatened in the future by the standards for nitrates being exceeded. Ground water supplies at seven of 45 systems require treatment for volatile compounds and for naturally-occurring radon.

4. Water Quantity

On an annual basis, nearly 800 million gallons per day (mgd) of water enters WMA #6 from rainfall (primary source) and potable water imports. Water leaves the management area by evaporation, streamflow, potable water exports to other management areas, and transfers of sewage for treatment at facilities in other areas. In 1995, over 100 mgd were withdrawn from surface and ground water sources in WMA #6 for various uses such as potable, industrial, and agricultural uses (NJDEP 1998). Potable water uses account for approximately 95 percent of the water used in the management area. In general, drinking water is provided by public and private purveyors, although a significant percentage of homeowners in some towns use wells.

About 70 percent of the water actually used in the management area is ground water from fractured bedrock aquifers and buried valley aquifers. Buried valley aquifers are located throughout the eastern portion of the management area as well as along stream corridors in the western portion. In some cases they are hydraulically connected to overlying streams. There are over 600 active drinking water wells that include both community and noncommunity wells. Several locations in MWA#6 are experiencing water deficits that cause significant drops in the aquifer level.

Surface water that accumulates in WMA #6 reservoirs and rivers is withdrawn at the rate of approximately 50 mgd (Boonton Reservoir) and supplied to municipalities in other management areas, primarily WA#5. The surface water reservoirs in WMA #6 are estimated have a total safe yield of approximately 72 mgd. However, severe droughts may significantly reduce this safe yield estimate.

5. Wetlands

Based on 1986 data, there are approximately 20,000 acres (41.4 square miles) of wetlands in WMA #6 (NJDEP 1998). This acreage accounts for about 8 percent of the land area. The Great Swamp, Great Piece Meadows, and Troy Meadows are significant wetlands in WMA #6. These wetlands, along with smaller ones, provide for the purification and recharge of surface and ground water, flood and storm damage protection, soil erosion control, and critical habitat for fish and wildlife. Wet habitats that occur between upland and water are generally considered wetlands. Based on their location and characteristics, wetlands include marshes, wet meadows, swamps, and bogs.

6. Riparian and Stream Corridors

The riparian areas in the management area consist of stream channels and associated wetlands, uplands, flood plains, forested areas, and other important habitat. The stream and river corridors in the management area contribute to water supply protection, surface and ground water quality, flood control, critical habitat for fish and aquatic wildlife, and maintenance of genetic diversity of native species. Stream encroachment activities by municipalities have been permitted by the New Jersey Department of Environmental Protection. Such permits regulate activities in the floodplain that potentially impact water quality, habitat and flooding. Areas of anticipated flooding have been identified along approximately 200 linear stream miles and include all major streams and most of their tributaries within WMA #6.

7. Flooding and Floodways

The Passaic River Basin is a unique drainage system. Prior to the last glacial epoch, the Rockaway, Whippany, and Upper Passaic Rivers in WMA #6 flowed in a southerly direction through a gap in the second Watchung Mountain. Upon eventual retreat, the largest glacial lake in New Jersey formed. Eventually, the Passaic River and its tributaries were forced to flow in a northerly direction. Since the new outlet to the sea is considerably higher than the original outlet, the river channel became extremely flat and the low-lying adjoining areas absorbed the energy of the flowing water. This in turn caused the former lake bed to fill with sediment to form swamp and meadowland that is known today as the Great Swamp, Troy Meadows, Great Piece Meadows, as well as others. As such, these wetlands that constitute the ancient lake bed, provide a natural retention basin.

The physiographic and historic conditions of the area, coupled with contemporary development, have resulted in a long history of flooding in the Passaic Basin. Significant flood events have occurred in the area to the extent that national declarations of emergencies were issued for floods in 1968, 1971, 1975, 1984, and 1992.

C. BIOLOGICAL ENVIRONMENT

1. Vegetation

Watershed Management Area #6 supports or has supported various vertebrate and invertebrate species as well as over 100 vascular plant species that are "rare, threatened, or endangered" in New Jersey. Nearly all municipalities in WMA #6 have recorded occurrences of rare plant or animal species. Rare vascular plants with more than five sightings each include downy phlox, Virginia bunchflower, and scarlet Indian paintbrush. Rare communities in WMA #6 include Hardwood-Conifer Swamp, Glacial Bog, and bat hibernaculum.

Based on a 1987 USDA forest inventory, the predominant tree species in Morris County, the primary county in the management area, are chestnut oak, northern red oak, black oak, white oak, and hickory. Hemlock commonly grows in wet habitats along streams, ponds, and lakes. There is an estimated 2.7 square miles (1700 acres) of hemlock in WMA #6. Hemlock stands are currently infested by the woolly adelgid, an insect that can cause mortality within two to four years from infestation. Ninety-five percent of the hemlock trees on the Picatinny Arsenal are dead (NJDEP 1998). Hemlock losses may affect water quality and associated terrestrial and aquatic ecosystems.

2. Wildlife

Rare vertebrate species found in more than 20 municipalities include the barred owl, wood turtle, and red-shouldered hawk.

3. Aquatic Resources

Some reaches of rivers in WM#6 support either natural trout reproduction or trout stocking. Clear, cold rivers with high dissolved oxygen are needed for trout reproduction. Natural reproduction of brook, brown, and rainbow trout occurs in some portions of the three watersheds in WMA #6. Natural reproduction of trout is rare in New Jersey. Adult trout are stocked annually in the Rockaway River Watershed. They are also stocked in portions of the Passaic and Whippany Rivers.

Warm water fisheries in the lakes and ponds include the two native species of chain pickerel and yellow perch, and several introduced species such as bass and sunfish. Channel catfish and northern pike are also stocked in the lakes and, except for the introduced species, fish populations in the major lakes are similar to those found in the 1950s. Warm water fisheries in rivers and larger streams in the management area include bass, sunfish, sucker, and a variety of smaller fish. Selected chemical testing of fish from streams in the state has resulted in fish consumption advisories for largemouth bass and chain pickerel.

Common freshwater mussel species, such as the eastern elliptio, are known to occur in WMA #6. There are also two recorded sightings of the less common triangle floater mussel. The triangle floater tends to be less tolerant than the eastern elliptio of poor water quality conditions. Although there are historic records of more rare mussels, no recent sightings have been reported. Typically, freshwater mussels require good to pristine water conditions in order to thrive.

D. OTHER IMPORTANT RESOURCES

1. Recreation

Crisscrossing the watershed are trails connecting local communities with public recreation and open space lands. Trails frequently form the backbone of greenways that protect river and stream corridors. Trails provide the public with the opportunity to appreciate the rivers, habitats, animals, and larger landscapes. The most notable of the trails in the region is Patriots' Path that connects all parts of Morris County. It provides both a wilderness path and urban walkway. In some sections, mountain bikers, cyclists, and horseback riders are also permitted on the trail. Over 30 miles of trail creates a maze of pathways throughout the county. Within the watershed management area, one branch follows the Whippany River north from Morristown. An offshoot from the Whippany River pathway crosses Troy meadows. Another links Morristown National Historical Park and Lewis Morris County Park.

2. Open Space

Approximately 17 percent of WMA #6 is designated by NJDEP as public open space (as of 1998). That is, land owned or managed by federal and state agencies, county and municipal governments, and nonprofit conservation groups. Public open space is land that is used for natural resource protection, recreational purposes, or agricultural preservation. State and federal open space parcels (including Picatinny Arsenal) total about 10 percent of the area. Morris County parkland is slightly under seven percent. The remaining portion is comprised of state conservation easements.

